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RAILWAY MAKING IN CHINA.

By Thos. H. Reid.

The crux of the complications in the Far East is the competition for opportunity to exploit the almost untouched resources of the Chinese Empire. It is anomalous that the largest factor in the field, so far as the northern provinces are concerned, should be Russia—a country wholly unprepared to supply the engineering equipment and promote the industrial development which have always accompanied Anglo-Saxon influence in new lands. It is of interest therefore, at a time when so much is heard of Russian aims in north-eastern Asia, to contrast her record with the character and spirit of the work actually done by Americans and Englishmen in South China.—THE EDITORS.

ALL recent writers are agreed that one of the most pressing needs of China, politically, strategically, and commercially, is the means of rapid transit. Already falling into disrepair or taxed to their utmost capacity in congested areas, the wonderful waterways of the country do not provide those facilities which are necessary for the development of China's potential resources. Travel by shallow rivers and canals is invariably slow, often dangerous. Days and weeks are consumed in penetrating the interior, and large tracts of country far distant from the centres of population are uncultivated, or lie with their mineral treasures untouched because of the lack of communication. Thousands starve annually in one province while there is an abundant harvest in an adjacent province—merely because transport, at all times difficult, becomes impossible at times of famine. The import trade of China is restricted because the cost of transit added to the native customs levies makes it impossible for foreign goods to penetrate to the far distant interior; the export trade is limited in like manner and the purchasing power of the people thereby

reduced. It is claimed by the advocates of railways that improved communication would enable the central government to exercise more efficient control of the provinces, would enable the officials to put down rebellious movements in their incipient stage, give the government the ability to concentrate quickly masses of men upon threatened points in times of war, distribute the people from congested to less populous provinces, provide facilities for famine relief, develop inter-provincial trade, and create channels for the distribution at cheap rates of foreign goods entering at the treaty ports.

In his excellent work "China in Transformation," Mr. A. R. Colquhoun, who knows China thoroughly, thus sums up the case for railways:—

> "The importance of rapid, direct, and practicable communications, that would enable the Chinese to develop the resources of their territories, and to open through communication with their neighbours, thus providing new arteries of commerce, is an axiom which should need no demonstration. These communications should satisfy industrial and commercial interests, while meeting political and administrative necessities. In the present deplorable condition of China (he was writing in 1898), no measure can render her greater service than the introduction of railways. 'Steam or Anarchy,' as Williamson said thirty years ago, are the only alternatives left to the Chinese people."

It is not my intention to discuss how it is that a people so practicable, possessing a high class of shrewdness, intelligence, and adaptability, and, above all, so thoroughly imbued with the commercial instinct, should be so backward in this matter of communications. The fact remains that of all civilised peoples the Chinese are the most backward as a race in the application to daily uses of modern mechanics; but it may be regarded as a hopeful augury that they are awakening to a sense of their own backwardness, and at the treaty ports are not slow to abandon their cumbrous native boats for the more mobile steam launch, which, if more expensive at the beginning, rapidly repays its owner for his enterprise. Advocates of the railway find in this a proof that the Chinaman will avail himself readily of better means of travel than is now available, and the experience in North China is certainly in their favour; for in 1897 Mr. Colquhoun found the new means of conveyance so much in favour that crowds were travelling to and fro for the mere novelty of the thing.

Devoting myself entirely to the railways of South China, it may be remarked *en passant* that the first railway laid down in China was a small line connecting Shanghai and Woosung. It was constructed in 1876 with British capital, was sold a year later to the Chinese local

authorities, and taken up by them, because of the hostility of the natives, and the material used in Formosa and North China. A small line was then constructed from the Kaiping coal mines, in the neighbourhood of Tientsin, to the Petang River, gradually growing to a very excellent line of over 300 miles in length, and now it is possible to travel from Peking to Port Arthur (the new Russian naval and military base in the Gulf of Pechili) and thence to Europe by the Eastern Chinese Railway in Manchuria and Russia's great strategical line in Siberia. Various railway projects are on foot in North China and in the Yangtsze Valley, but the most important of all is the Luh Han Railway, now in course of construction by a Belgian syndicate. It will join Peking with Hankow, the great industrial city at the junction of the Han River with the Yangtsze-Kiang, and forms the northern portion of the Grand Trunk Line of China. South of the Yangtsze, the principal project is the Yeun Han Railway, which will connect Wuchang (the southern complement of Hankow) with Canton, thus completing the Grand Trunk, and giving, when constructed, through railway communication practically from Hongkong to Calais by Hankow, Peking, Port Arthur, Harbin, Irkutsk, Moscow, Warsaw, Berlin, and Paris. Between Canton and Samshui, the latter a recently opened treaty port at the junction of the North and West Rivers, there is a branch line supplementing the Yeun Han; and lines are projected between Canton and Macao (the ancient Portuguese colony in the Pearl River delta) and between Canton and Hongkong. The concession for the latter, which would be about 100 miles long, is held by British capitalists.

Canton, the southern metropolis of China, is situated on the left bank of the Pearl River. It was here that foreign traders first came into close relations with the Chinese. Intercourse in the early days was not always of a pleasant or peaceable nature, but in recent years the Cantonese, who are the most enterprising of all the Chinese, have become more reconciled to the *fan-kwei* or "foreign devil." Including those who live in boats on the river, Canton is reputed to have a population of 2,500,000 souls. The city is a perfect hive of industry, if a somewhat noisome and unsavoury one, and is in constant touch with the surrounding towns and villages, mainly by the waterways of the delta. At the western end of the city is the suburb of Wong Sha, where the terminal station and southern headquarters of the Yeun Han Railway will be established. At present the site is occupied by the offices of the American China Development Co., by which the main line and the branch line from Canton to Samshui are being con-

structed. Shek-wai-tong, on the right bank of the river opposite Wong Sha, will be the headquarters of the branch line. Fatshan, 11 miles away, is styled "the Birmingham of South China," on account of the varied character of its manufactures. It has a population of about 500,000 souls, and Sainam, about 17 miles further west, a population of 50,000. Sainam also has varied manufactures, and is of far more importance than Samshui, three miles beyond, to which the railway has been pushed with a view to shorten the journey between the West River and Canton. Going from Canton to Samshui by a fast steam launch through the creeks the journey occupies at least 3½ hours under favourable conditions, but going by the West River route on a powerful shallow-draft Thorneycroft stern-wheel steamer it takes 12 hours.

Once away from the delta with its bewildering maze of waterways, the main railway, which I now proceed to deal with in detail, presents no serious engineering difficulties. As will be seen from the accompanying map, it runs almost due north, passing through Yingte (or Yingtak), Shao Chou, Chang Chou, Heng Chou, Chang Sha (the capital of Hunan Province), and Siang Yin to Wuchang. It follows the course of the North River in Kwangtung Province, and crosses the watershed into the Yangtsze Valley by a pass, now designated

"Parsons Gap," 1,000 or 1,200 feet above sea level. This pass was discovered by Mr. Wm. Barclay Parsons, who carried out the original survey for the American Syndicate. It is just to the west of the famous Che-ling pass, over which the tea and other produce from the northern slopes of the mountains used to be carried to the Canton market. Since steamboat traffic developed on the Yangtsze, and Shanghai and the Yangtsze "open ports" have become an important outlet for native produce, the Che-ling pass has been almost entirely abandoned as a trade route; and it is interesting to note in passing that it is strange that a practical people like the Chinese should have continued to use the Che-ling pass for many a century when there was a considerably lower pass at no very great distance on the watershed. The main line can be carried over the mountain on a low gradient. At no point will the gradient be greater than one foot in 125 approximately. It will be a single-track 4 feet 8½ inches gauge with all the characteristics of the Canton-Samshui branch line to be described hereafter. There will be a few tunnels, and fairly heavy rock work for about 100 miles north of Canton, but as there are no roadways in China, only the merest footpaths, no overhead bridges will have to be constructed. The total length will be 750 miles. In 1904 it is intended to construct 150 miles from Canton northwards and 150 miles from Wuchang southwards, and it is anticipated that the whole of the main line will be finished in January, 1906. None of the bridges would be considered long by engineers, and they are not likely to present any serious difficulties. Standard lengths of steel girders will be utilised, and cement concrete for abutments and piers. From Canton to Kong-hau, the line passes through rice country; near Yingtak the country is hilly, and there is at various points along the route good mineral land, which the railways will help to develop.

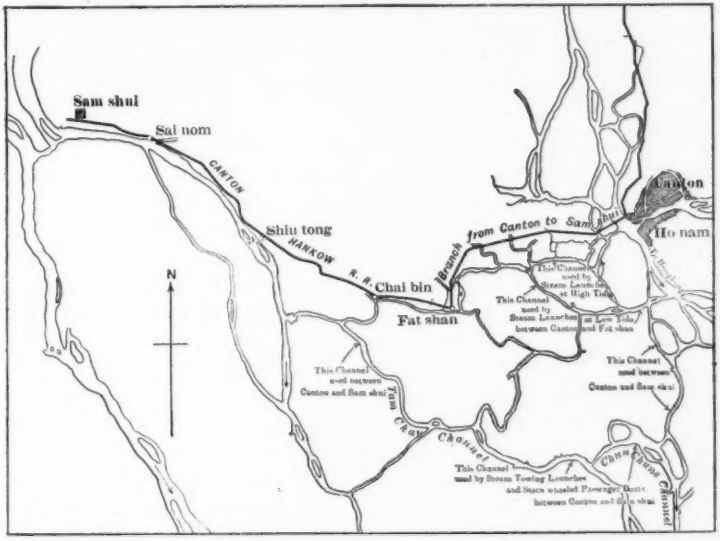
The first 110 miles from Canton have been re-surveyed by what the American engineer calls "locating parties," and two locating parties are at work in the Province of Hunan. It is curious to notice that whereas in the hermit Province of Hunan—the last to open to foreign influence and residence—the officials have done all in their power to render the work of the survey party easy, in the Kwangtung Province, which has been in touch with foreigners for some centuries, there has been a certain amount of active hostility and still more "passive resistance."

There have been no anti-railway riots in Hunan, no attacks upon the surveying parties. At Yuantang, on the North River, in the month of April, there was, on the other hand, a very serious attack upon the

surveyors, which might easily have developed into a lamentable tragedy. Some of the villagers in an outlying village near Yuantang objected to the railway passing through or near their village, and they were incited by an old woman to attack the engineers. The old lady beat a gong to attract the natives from the rice fields, and when the petty mandarin attempted to take the gong from her she harangued the mob. With cries of "ta, ta" ("kill, kill") the incensed natives began their onslaught, led by a man with a heavy two-handed sword. The mandarin had a narrow escape of having his head cleft in two, and the survey party had to execute a strategic movement across the river to the village of Yuantang, where they had their camp. The infuriated natives opened fire with muskets from the opposite side, and when the surveyors abandoned their houseboat and sought safety in an adjacent temple, the natives crossed the river and besieged them for four hours. Had they known how helpless the surveying party was, they might easily have rushed the temple and slain the defenders, who had no arms. The villagers of Yuantang had no grievance, and the elders of that village, not wishing to incur the displeasure of the higher officials, were successful in persuading the rioters to return to their own village by a promise to hand over next morning the unwitting cause of the trouble. In the darkness, the surveyors regained their boats, and dropped down the river to Tsing Yuen, and reported the matter to the prefect. In the meantime, Mr. Burns, the first assistant engineer, had gone up the river in a steam launch, and encountered the wreck of the surveying instruments and rods floating down the river. Seeing that some Europeans were in difficulties with the natives but were holding their own on the Yuantang side of the river, he posted back to Canton, whence the U. S. gunboat Callao was despatched. As it happened, the surveyors escaped without hurt, but the incident might well have been more serious.

Ancestral graves prove one of the most serious obstacles to railway making in China, and wherever possible the engineers have avoided them. Sometimes exorbitant prices are demanded for the removal of an ancestor's remains, but through the influence of Chinese interested in the railway something like uniformity has been arrived at, and the average price now paid for a grave is Taels 4 (about 10 shillings). Consideration of native susceptibilities entails additional expenditure, but it may be regarded as a fortunate circumstance that the railway lies some little distance from the towns and villages, for as soon as its economic value is recognised by the people they will doubtless construct connecting roadways on Western principles, with perma-

nent benefit to a country which has trade routes but no roadways. So far, the only preparation for the main line is a large reclamation at Wong Sha, on the Canton side of the river. This will be the site of the southern terminus, but there is an idea of constructing an overhead line from one end of the city to the other, and of continuing the main line to Whampoa, about ten miles further down the river, where wharves and docks could be erected and ocean liners with a draught of 30 feet come up at any state of the tide and load and discharge cargo. Years ago, before Hongkong became a British colony, the P. & O. Co.'s Eastern steamers docked at Whampoa, where the first graving dock in China was built by a Scotchman named Couper. This dock was acquired subsequently and abandoned by the Hongkong and Whampoa Dock Company, Limited, which at the present day controls the whole of the dock business in South China, and has a ship-


Sam shui
Sai nom
CANTON
Shiu tong
HANKOW
R. R.
Chai bin
Branch from Canton to Sam shui
Canton
Ho nam
N
Fat shan
This Channel used by Steam Launches at High Tide
This Channel used by Steam Launches at Low Tide between Canton and Fat shan
This Channel used between Canton and Sam shui
This Channel used between Canton and Sam shui
Tam Chau Channel
This Channel used by Steam Towing Launches and Steam wheeled Passenger Boats between Canton and Sam shui
Chim Chau Channel

MAP OF THE LINE FROM CANTON TO SAMSHUI.

building and repairing establishment capable of undertaking the docking and repair of the largest merchant vessels and warships. It will be a curious turn of affairs if Whampoa should regain its old importance by becoming the port of Canton, and interesting speculations might be made upon its effect on Hongkong.

I come now to the consideration of the branch line between Canton

and Samshui. The large brick station at Shek-wai-tong will have all the usual accommodation for railway officials, passengers, and customs officials. The other principal stations on the line, which will be 31 miles long, will be at Fatshan, Sainam, and Samshui; but small stations with small landing platforms and shelter for passengers will be erected near the more populous villages on the route. Large ferry boats will convey passengers across the river to Wong Sha.

The grading or embankment for this branch line is completed between Shek-wai-tong and Fatshan, the rails partially laid, and all the bridges and culverts well in hand, and it is arranged to open the line for traffic as far as Fatshan in the month of November. In the first ten miles there are thirteen steel-girder bridges and four culverts in the latest type of reinforced-concrete construction. Of the thirteen bridges one is 10 feet long, two 15 feet, five 20 feet, two 60 feet, and three 120 feet long, the latter made up of one 60-foot span and two 30-foot spans in the clear. The bridges are founded on timber piles, and the abutments and piers are of concrete, with granite bridge seats. These bridges are designed to carry 130-ton locomotives, and are the type that will be used in the construction of the main line. The girders are now at Shek-wai-tong, and as soon as the abutments are finished—a matter of a few weeks—the girders will be placed in position. All the girder work is in standard sizes.

The line runs over alluvial deposit, and in constructing the embankment, the engineers have obtained their material from borrow pits along both sides of the line. It is almost entirely blue clay, with a small amount of sand in certain localities, and though stiff to work, especially in the wet season, makes a substantial surface. On the double track between Shek-wai-tong and Fatshan the formation width on the embankment is 31 feet, with slopes of 1½ to 1. The maximum grade is one-half per cent (1 foot in 200). The maximum curvature is 3 degrees (1,910 feet radius), and on these curves there is a spiral or easement curve. There are only two on this double-track section. At one point considerable trouble was experienced owing to the settlement of the embankment for a distance of about 1,200 feet, and after investigations the engineers decided to cease operations in the borrow pits, and the subsidence is being filled up with sand from the river.

At Fatshan the line is on the same level as Canton. The average height of the embankment is from 3 to 4 feet above the level of the rice fields, rising to a height of about 15 feet at bridges. No large rivers are crossed, only sluggish streams, and at one or two of the bridges the junks will have to unstep their masts in order to pass

COOLIES WHEELING CLAY FROM A BORROW PIT.

beneath. No flooding is anticipated, as the grading is well above extreme high water.

The gauge is the standard one of 4 feet 8½ inches, which will make the line uniform with those of North China, and there is an 8-foot way on the double track. The rails weigh 75 pounds per yard, and are 30 feet long. The track will be ballasted with broken stone to a depth of 16 inches, but the railway will be opened to traffic before this is completed. The sleepers are of steel, about 8 feet long, and weigh about 125 pounds. Like the rails, they come from Belgium. The sleeper is of the rolled form, cut off in lengths, and the ends bent over. The rail is fastened to the sleeper by means of steel clips and bolts. All bolts are provided with spring washers to prevent the nuts from working off.

All the rolling stock will come from America. The locomotives will weigh 130 tons. Passenger carriages will provide accommodation for three classes. The freight cars are of 80,000-pounds capacity. There are twenty cars and five light locomotives—the locomotives formerly in use on the New York Overhead—now in the terminal works at Shek-wai-tong. The signalling arrangements have not been completed yet, but it is expected the line will be operated by Americans upon the American system.

All the cement used on the works is supplied by the Green Island Cement Co., Ltd., of Hongkong.

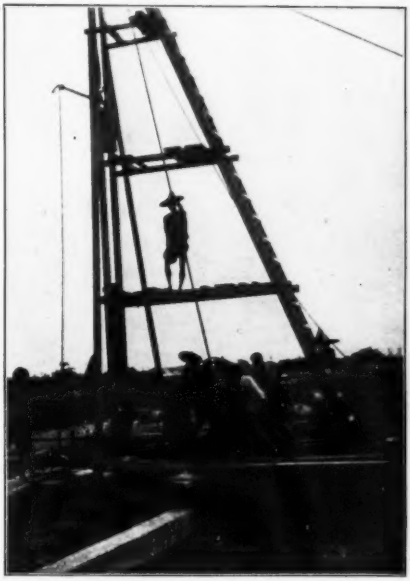
As might have been expected by anyone who knows anything of Chinese guilds, the greatest trouble of the engineers carrying out the work was with the contractors. They failed to fulfil their contracts on time, and in order to get the work finished expeditiously and properly, the company had to take over the whole of the bridging and grading themselves, organising their labour and getting material and implements, such as wheelbarrows, pile-drivers, pumps, etc., for themselves. Since this was done there has been no trouble with the coolie labour. One of the engineers say that it is a fallacy to say that Chinese labour is efficient or cheap, and he sighed for Irish navvy labour, which he maintains would be less costly, more efficient, and would enable the engineers to gauge with a greater degree of certainty the time likely to be occupied on constructional work. Each coolie, man or woman, receives 40 cents per day (11 pence), which is about double the pay of

COOLIES CARRYING SAND FOR AN EMBANKMENT.

ordinary coolies in China. Sometimes a portion of the gang will strike work, but, on the whole, there is no longer any serious difficulty, and as the company endeavours to get its labour from the villages along the route this has had some effect in producing a pacific attitude.

When consideration was given to the delays caused by Chinese subcontractors, it must be said that the progress of the work is quite satisfactory. The preliminary survey of the Fatshan section was made

in August 1902, and the final survey was completed on January 1 this year. The route of the Fatshan-Samshui section was finally located in April, and ground was broken for that section on September 8. Work was begun on the Canton-Fatshan section in the first week of March, and it will be finished by the middle of November. The Fatshan-Samshui section (which is a single track) will be finished in January next. On that section there are one or two heavy cuttings through clay, but fewer streams to cross and only one large bridge.



PILE DRIVING BY HAND POWER.

I have already mentioned that the lines now in process of construction in South China are being built by the American China Development Company, a purely American company with a capital of $30,000,000 (gold). Mr. Wm. Barclay Parsons is president. The actual work of constructing the main railway and its branches is under the supervision of Mr. Willis E. Gray, general manager, whose head office is at Shanghai. Capt. C. W. Mead is the chief engineer, and Mr. Justin Burns the first assistant engineer. Mr. C. H. Farnham, division engineer, is at the head of the engineering staff on the Canton-Samshui branch line. The foremen of works comprise Americans, Englishmen, Irishmen, Scotchmen, Australians, Frenchmen Germans, Scandinavians, etc., mostly engaged locally or in the Philippines. These men are quartered in large houseboats on the principal streams along the line of railway, and, considering they are engaged on pioneer work, they have, on the whole, a very pleasant time. For the protection of the works generally the company has a uniformed force of 500 native soldiers, armed with rifles and carbines, but no serious disturbance has occurred as yet on this portion of the line.

I am not in a position to discuss the question whether the line will

NATIVE SOLDIERS AND LIEUTENANT.

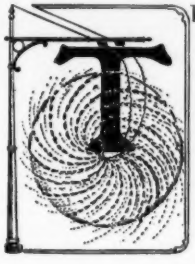
pay interest upon capital. Personally, I believe railways will be a successful enterprise in China. Progress may be slow in the first few years; but I incline to the view that as railways will have a far-reaching effect upon the national and provincial life of the people, the reaction will be altogether in favour of the pioneer lines, and the effect will be more rapid than most people contemplate. Where the railway competes with water carriage over short distances the Chinese will undoubtedly prefer the passage boat or steam launch. But over long distances, where the railway will carry him safely and quickly, the Chinaman will most certainly choose the railway.

A necessary complement to the Yeun Han Railway is the continuation to Hongkong. In the interests of that colony this line should be undertaken at once, before Canton or Whampoa can become established as the terminus, for if either of these places becomes the chief distributing centre of South China, the commercial value and importance of Hongkong will be seriously endangered. Looking at the question of railways in China in the broadest aspect, however, it must be confessed that the outlook is most encouraging, and the advent of the railway in this vast empire the result will be, as it has been in all other countries, a social improvement in the condition of the masses of the people, coupled with an enormous expansion of national wealth and individual prosperity, and the reformation of a system of government that has grown corrupt with the ages and out of touch with the people and their requirements.

THE WATER POWERS OF BRITISH COLUMBIA.

By E. Jacobs.

It has been pointed out more than once in these pages that natural and economic conditions all assure a most brilliant and almost boundless industrial future for the Pacific Slope of North America. One of the chief elements in that development is the vast power resources of the region. The accompanying brief but vigorous sketch of some of the most important water-power installations north of the Canadian boundary will be followed by a similar study of the larger work in the Pacific States.—The Editors.



THE Dominion of Canada is stated to have a lake area of 77,391,304 acres. Of this large acreage in lakes British Columbia's proportion is at least 2,000,000 acres. In an official bulletin, published by the Government Bureau of Provincial Information early in 1903, a table appears showing the individual areas of sixteen of the larger lakes, ranging from Adams Lake with 33,280 acres up to Atlin Lake with 211,680 acres, and placing their aggregate acreage at 1,560,830 acres. Whilst the water area of the Province is small in comparison with, say, that of Ontario, which has an area of 25,826,306 acres in lakes, it is yet large enough to make it an important feature in the physical characteristics of the Province in their bearing upon its commercial and industrial economy. This is especially the case where the elevation of the lakes and their accessibility are such as to make reasonably practicable the utilisation of their waters for power purposes. It is, though, the rivers and creeks of the Province rather than the lakes that, with one important exception, are being more and more utilised in this direction.

The several extensive mountain ranges of the Province furnish abundant sources of power, not in all cases available the whole year round, yet generally for a sufficiently long season to make it well worth while taking advantage of the power whilst applicable. There are four main ranges; three on the mainland, viz., the Rocky, the Selkirk, and the Coast ranges, and one, known as the Island range, forming the archipelago of islands, great and small, lying to the west of the mainland. These mountains provide immense watersheds, the rains and melting snows passing from them by innumerable watercourses into the rivers and lakes that drain their slopes. The average width

UPPER FALLS, KOOTENAY RIVER, NEAR NELSON, B. C.
As yet undeveloped for power purposes.

of the Rocky Mountains, the central heights of which form the eastern boundary of British Columbia, is about 60 miles, diminishing to the north; that of the Selkirks is about 80 miles, whilst the Coast range has a mean width of about 100 miles. The average height of the Rockies in the Province is given as about 8,000 feet, though several summits occur a little north of the International Boundary line with elevations exceeding 10,000 feet. Higher altitudes are reached where this range appears to culminate in Alberta. The Selkirks enter the Province from the south in a threefold system, known respectively as the Purcell, the Selkirk, and the Gold Mountains. Northwards they are known as the Cariboo Mountains. Their summits rise to 8,000 to 9,000 feet above the sea. The Coast range reaches an average height of about 6,000, with some peaks 7,000 to 8,000 feet high.

The valleys of British Columbia fall into two classes, (1) main or longitudinal valleys, in general having a north-and-south trend, and (2) tributary or transverse valleys, with a prevailing east-and-west direction. The main valleys lie in about the course taken in glacial

days by the ice, which chiselled out these long fiord-like valleys as it moved southwards over the country. They are deep and for the most part level, or with only a slight gradient. The transverse valleys lying across the path of the ice were not deepened to the same extent; consequently when the ice disappeared they did not enter the main valleys on grade, but stood above them, often at a considerable height, as hanging valleys. The streams are still cutting these down to the level of the main valleys, by wearing back canyons having waterfalls at their heads. As a consequence most of the water powers are on the east-and-west valleys, many of these tributary valleys possessing waterfalls suitable for water-power purposes, these varying with the size of the stream. This frequent occurrence of available power, usually within easy reach and conveniently situated for industrial purposes, has already been taken advantage of in many instances in the Kootenay mining districts, where numerous concentrators, stamp mills, electric-light plants, etc., are in operation, the considerable pressure head obtainable from a comparatively small stream in a short distance making effective installations practicable at moderate cost. In a general way it may be stated that these tributary valleys furnish power, whilst the longitudinal valleys afford facilities for transportation.

The unique position of British Columbia as a watershed on the west coast of America will at once be recognised when it is seen that the rivers of great importance on that coast, with the exception of the Colorado and the Yukon, take their rise within its boundaries. The drainage from its extensive area of mountains and highlands is received into the numerous lakes already noticed. Thence the surplus is discharged into the few large rivers, or their many tributaries, which finally reach the sea. These rivers are the Columbia on the south (debouching through United States territory into the Pacific Ocean); the Fraser (750 miles long), the Skeena (300 miles), and the Stikine, on the west; the Liard (more than 300 miles in British Columbia) on the north, and the Peace (also more than 300 miles in British Columbia) on the east. These rivers are of great size and volume, and the first-named four are sufficiently navigable to steamers to form waterways of no small value in the development of the country.

So far as known to me no official or other competent survey or report has been made of the water power available in British Columbia. This summary of the water-power resources of the Province must, therefore, of necessity be very incomplete. In the absence of the data requisite for making an estimate of the total available hydraulic power, all that will be undertaken will be to direct attention to the more

SITE OF THE CONCRETE DAM, VANCOUVER POWER COMPANY'S POWER PLANT.

prominent instances in which some of this abundant power is already in use, or to preparations being made to utilise it. Perhaps the more interesting are undertakings where the hydraulic development of electrical power involves the installation of electrical and transmission plant, but before turning to these, several representative cases of the direct application of hydraulic power, including one of hydraulic placer mining, will have notice.

The official statistics of the Provincial Department of Mines show that during forty-five years—1858 to 1902—the production of placer gold in British Columbia totalled in value $64,627,683. The annual yield ranged from a maximum of $3,913,563 in 1863 to a minimum of $356,131 in 1893, and the average yearly yield over the whole period was $1,436,171. During recent years hydraulic mining has contributed materially to the production of placer gold. This industry has received most attention in the Cariboo and Cassiar Districts, both in the northern part of British Columbia. During several years last past, however, the rainfall in these districts was considerably less than in earlier years and consequently hydraulic operations were proportionately restricted, but this state of affairs is not expected to continue indefinitely; in fact, the present outlook promises a change for the

better next season. Whilst in the past the greater portion of the placer gold yield came from the richer and shallower gravels—$25,000,000 to $30,000,000 are credited as the production of 2½ miles of Williams Creek and 2 miles of Lightning Creek, both streams in the Cariboo District—it is from the immense auriferous deposits contained in the older and deeper channels, which must be worked by hydraulic methods, that large returns may be expected in the future. Of the numerous hydraulic placer-mining enterprises of British Columbia the most important is that of the Consolidated Cariboo Hydraulic Mining Co., Ltd. From a report made in 1900 by the manager, Mr. J. B. Hobson, the following is taken:

> "The company's property is located in the Quesnel River mining region, famous for its rich shallow placers, its extensive system of ancient river channels, and its immense deposits of auriferous gravels. It is situated at Bullion, Cariboo District, about 190 miles by waggon from Ashcroft, on the main line of the Canadian Pacific Railway. The property comprises 34 placer-mining leases, aggregating 2,584 acres of land. These mining leases cover, for a distance of about 10 miles, the auriferous deposits of a system of ancient rivers. The deposits included in the company's property vary from 400 to 600 feet in depth from surface to bottom of channel. The quantity is estimated at 500,000,000 cubic yards of auriferous gravel that is available for future washing by hydraulic process. The company's water-supply system, as now completed, consists of 33 miles of well-constructed canals, having a capacity for delivering at the mine 5,000 miner's inches of water under a head of 420 feet. The sources of supply are at three lakes 10 to 19 miles distant, these having an aggregate capacity for storing 1,016,000,000 cubic feet of water, which is equal to 470,370 miner's inches of water. This storage supply is greatly augmented by the waters of streams tributary to the main canals between the storage reservoirs and the mine."

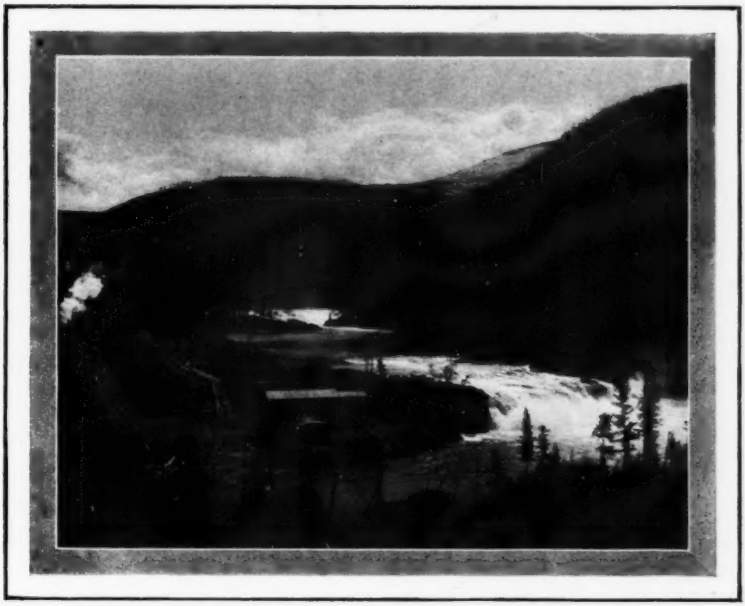
The mine equipment, which is an extensive one, includes a portable hydraulic plant of four lines of 30-inch and 22-inch rivetted steel pipes, aggregating 6,000 feet, and six No. 8 hydraulic giants, with deflecting nozzles, varying from 6 to 10 inches in diameter. The gold-saving appliances consist of a double-extended system of sluices 7 feet wide by 4 feet deep, aggregating 2,380 feet in length; also two improved undercurrents of longitudinal steel riffles, for the recovery of flour quicksilver, fine gold, platinum, and osmiridium that cannot be recovered in the ordinary sluices.

As illustrative of the difficulties that follow an insufficient rainfall it may be mentioned that instead of being able to hydraulic the full mining season of six to seven months, this company had in 1901 only enough water for 104 days' run, and in 1902 for 66 days' run. In the

former year 2,420,288 cubic yards of gravel were moved, this yielding $142,275, and in the latter 690,442 cubic yards producing $61,395.

As examples of numerous concentrating plants in the Slocan District mention may be made of the Whitewater silver-lead mine, where five 24-inch Pelton wheels, driven under a 450-foot head of water brought in only 2,500 feet, operate a 200-ton concentrator; and of the Enterprise mine, where Peltons under 110-feet pressure head of water brought 3,000 feet, drive a 75-ton concentrating mill together with a direct-connected air compressor. At the Ymir gold mine, in the Nelson District, an 80-stamp mill, with vanners, etc., of a daily capacity of 200 tons, is operated by Pelton and Tuthill wheels driven under a 430-foot head with a 4,500-foot flume. In the same mining district a water-driven 20-stamp mill at the Poorman mine crushes 40 to 45 tons of gold quartz daily, whilst at Ainsworth the Highland mine 150-ton concentrator, also operated by water power, works right along on silver-lead ore. During a recent trip into the Lardeau District I saw nearing completion at Camborne, on Fish River, two 10-stamp mills for treating gold quartz from the Eva and Oyster-Criterion mines, respectively, power being obtained from a neighbouring creek. In the same district the Union Iron Works, of San Francisco, Cal., is erecting near Ferguson for the Silver Cup Mines, Ltd., a 20-stamp combination silver mill to be run by electricity generated by power taken from the South Fork of Lardeau Creek, a pressure of 140 feet being obtained with a flume about 4,000 feet in length. Again, the Stave Lake power, in the Lower Fraser District, has lately been taken over by American capitalists, whilst on the coast, Clowhom River Falls, at Sechelt Inlet, have been secured by one company, and Powell River Falls, near Malaspina Straits, by another, both companies being interested in the establishment there of the pulp and paper industry. Scores of other instances might be cited, but these will serve to show that the water powers are being utilised to an increasing extent.

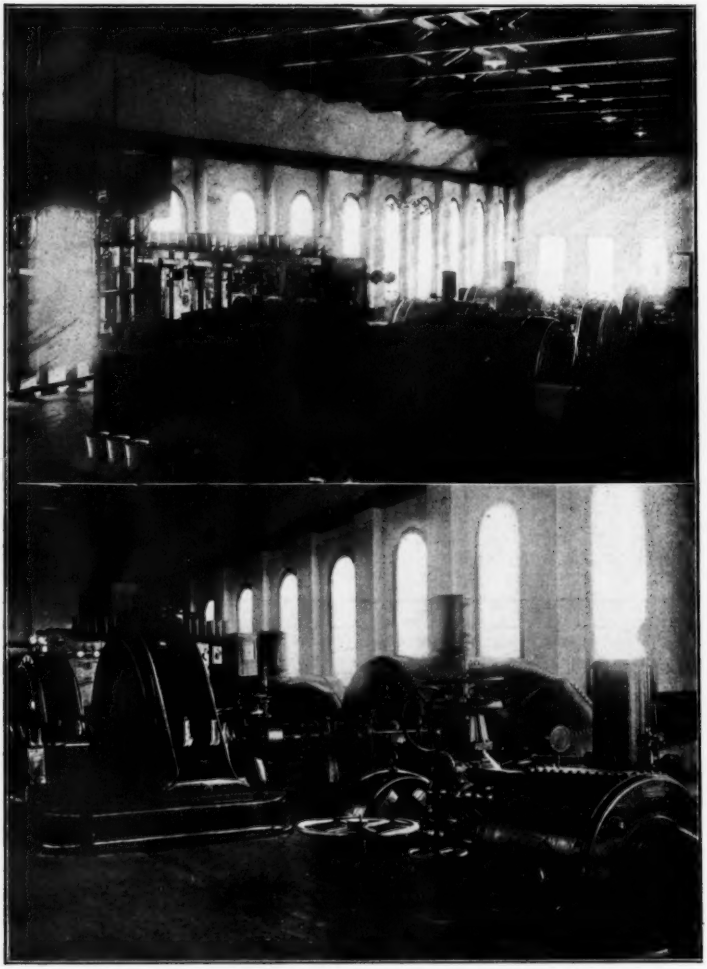
The most important hydraulic development of electrical power in the Province is that of the West Kootenay Power & Light Co., which for about five years has been developing power at Bonnington Falls, on the Kootenay River, about eleven miles west of the town of Nelson. The conception and commencement of this enterprise were largely due to Sir Chas. Ross, Bart., of Balnagown, Scotland, and Mr. Oliver Durant, the manager at Rossland for the Centre Star Mining Co., whilst to Mr. Lorne A. Campbell was entrusted the installation of the plant and the further execution of the plans of the company. Preliminary surveys were made early in 1897, and in July of that year



BONNINGTON FALLS, KOOTENAY RIVER, SHOWING POWER STATION IN FOREGROUND AND UPPER FALLS IN THE DISTANCE.

actual construction was commenced. Before the close of 1898 power was being supplied to mines at Rossland. The plant was built essentially for power purposes. Of its load only a comparatively small percentage is used in lighting, by far the greater part being in synchronous and induction motors for the operation of machinery at mines, smelters, manufactories, etc., and for a street-car service at Nelson.

It is estimated that Bonnington Falls, both upper and lower, have a capacity at low water of 267,000 horse power. The West Kootenay Co., however, is thus far utilising only a portion of the lower falls, which, under the 40-foot head available, are capable of delivering 100,000 horse power. A large reef of rock crosses the river, here about 400 feet wide. The power plant is located under the higher portion of this reef, the river falling over the lower part of it. A canal cut 650 feet through the rock opens out into a forebay 54 feet wide and closed in by a solid concrete dam. Three feeders open into steel penstocks run through the dam and into the hydraulic section of the power house below. These connect with three 39-inch Victor turbines. In the generator room are three 40-kilowatt 125-volt multi-



POWER PLANT OF THE CASCADE WATER POWER & LIGHT COMPANY.
The lower view shows the 750-kilowatt alternating-current generators; the upper shows the 250-kilowatt self-cooling transformers in the other end of the power house. The electric installation is by the Westinghouse Electric & Manufacturing Co.

polar exciters, and three generators—two 750-kilowatt units and one 1,500—of the Canadian General Electric Co.'s standard revolving-field type. From the generators the mains are led off underground to a 10-panel switchboard, and thence to the raising transformers, of

which there are twelve, each having a capacity of 250 kilowatts. An air blast is supplied to these by three 60-inch Buffalo blowers, each operated by a 2-horse-power 100-volt induction motor. The current is delivered to the transmission lines at pressure of 20,100 volts.

The power house is a brick building, with galvanised iron roof. It is divided into three compartments—a turbine room 25 feet by 64 feet, a generator room 31 feet 6 inches by 66 feet, and a transformer room 17 feet 6 inches by 28 feet. The transmission lines westward to Rossland 32 miles, with a 4-mile branch to Trail, and in the opposite direction to Nelson, are built over a rough heavily-wooded country. The variation in altitude at different points is more than 2,200 feet. There are two separate pole lines, each carrying three No. 2 B. & S. copper wires. The fireproof sub-stations at Rossland, Trail, and Nelson, are provided with transformers, switchboards, and all other apparatus necessary for the reduction of the current to a pressure suitable for use in mines, smelters, etc., and for lighting purposes in the towns.

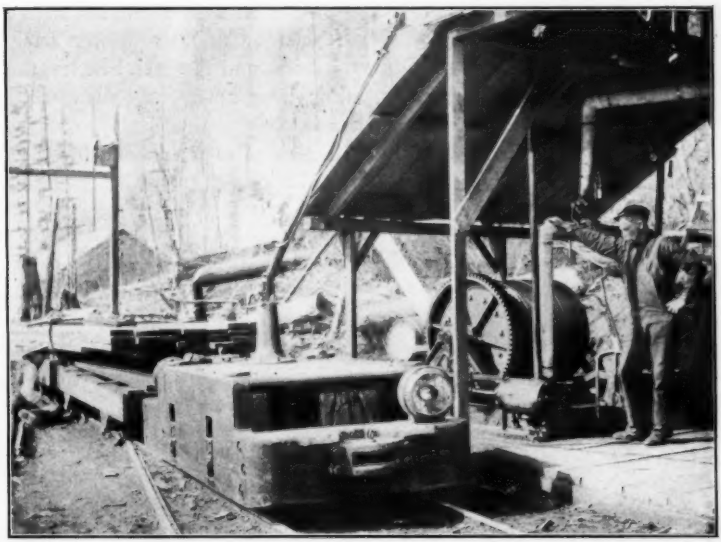
POWER HOUSE EXCAVATION, VANCOUVER POWER COMPANY.
Engineering Offices, San Francisco, engineers; Wynn Meredith, consulting engineer in charge.

The Vancouver Power Co. is installing a hydro-electric transmission plant designed to be capable ultimately of delivering 30,000 horse power to the cities of Vancouver and New Westminster and the neighbouring district. The initial installation will be equal to the genera-

tion of 9,000 horse power, which will be used for operating the inter-urban railway system of those cities, and for electric lighting. The undertaking was commenced in the early summer of 1902, and it is expected that it will be possible to generate power for immediate requirements by the end of 1903, but the completion of the works will yet be a matter of at least a year.

The sources of water supply are Coquitlam and Trout Lakes, both deep glacial lakes. Lake Coquitlam has an area of 2,300 acres, and it is at an elevation of 32 feet higher than Trout Lake, which is 460 acres in extent. Rugged mountains, rising abruptly from the shore lines, surround both lakes to their outlets. Between them a granite range rises 4,000 feet above water level, and it is through this range that a 9 feet by 9 feet tunnel, 13,000 feet or nearly two and one-half miles in length, is being driven to connect the lakes to admit of the stored waters of Coquitlam Lake being used for the main supply, Trout Lake being the balancing reservoir. The lakes will be controlled by dams at their respective outlets. That on Coquitlam Lake will be constructed of rock-filled timber crib, and it will raise the

TUNNEL PORTAL, TROUT LAKE, VANCOUVER POWER CO.'S INSTALLATION.
80 feet of overlying debris being sluiced out.

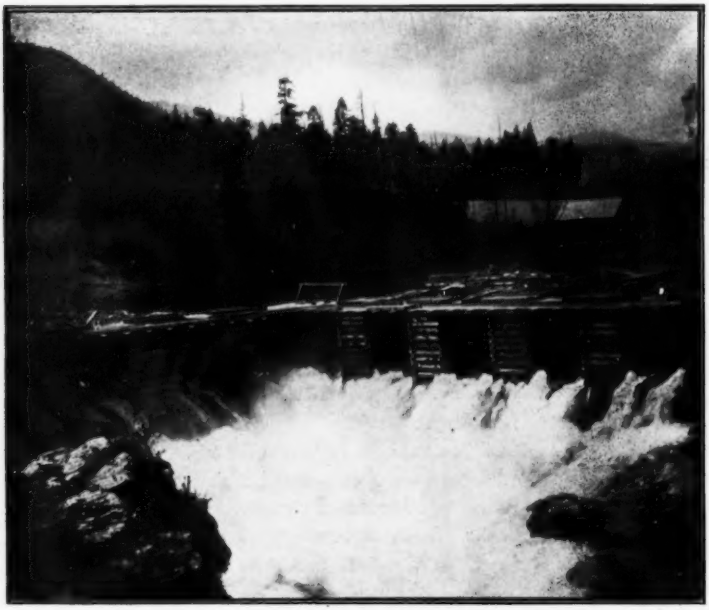


INCLINED TRAMWAY HAULING ENGINE AND ELECTRIC LOCOMOTIVE FOR TUNNEL HAULING, VANCOUVER POWER COMPANY'S CONSTRUCTION WORK.

water 12 feet above low-water level. That on Trout Lake is of concrete; it is 350 feet long on the crest and 50 feet high. Provision has been made for eventually bringing out ten 54-inch steel pipe lines, but for the present only three have been completed. These run 1,600 feet to the power station, in three sections of 48, 44, and 42 inches respectively, delivering the water under an effective pressure head of 390 feet.

The power house is substantially built, of granite masonry. The water-wheel equipment consists of three sets of Pelton impulse wheels, each capable of developing a maximum of 3,000 horse power, and one set of 200-horse-power wheels, all enclosed in cast-iron housings. Each of the main units has two overhung wheels, one mounted on each end of the shaft of a 1,500-kilowatt, 60-cycle, 2,200-volt, Westinghouse engine-type rotating-field generator. An interesting feature here is the combination of needle valve and deflecting nozzle in the regulation of the water wheels, this permitting of load and speed variations independent of any change of velocity in the pipe lines. The two 80-kilowatt exciters, with their respective wheels, are mounted on a common bed plate, with a 120-horse-power motor between them. The switchboard has nine panels—one for the induction motor and one for each

exciter, three for controlling the main units, and three for the three sets of 550-kilowatt air-cooled transformers with their blower sets, these last consisting of 20-horse-power motors and 110-inch Sturtevant fans. The step-up transformers, static interrupters, high-potential switches, and lightning arresters, are installed in a separate building placed above and behind the power house. The machinery for the



CASCADE WATER POWER & LIGHT COMPANY'S DAM, ON THE KETTLE RIVER, CASCADE CITY, BOUNDARY DISTRICT.

sub-stations at Vancouver and Burnaby includes the usual transformers, rotary converters, switchboards, etc., for the reception and distribution of transmitted power.

Two independent transmission lines, each consisting of two 3-wire circuits, of No. 2 copper wire, crossing Burrard Inlet with a span of 2,800 feet, run to Barnett, whence one connects with Vancouver at 16 miles from the power station and the other with the old power station at Burnaby. The existing transmission line between Burnaby and Vancouver will be reconstructed to carry 20,000 volts, the pressure to be used on the new lines, and a new line will be built from Burnaby to New Westminster. In effect a double transmission line will be

provided over the entire distance between the power station and each of the sub-stations.

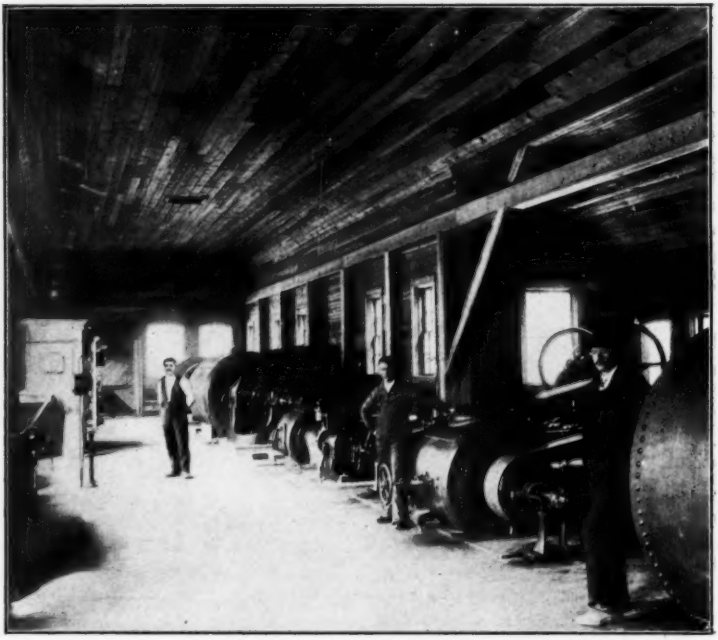
At Cascade City, in the Boundary District, the Cascade Water Power & Light Company has constructed a dam across Kettle River, where there is a water power estimated at between 6,000 and 7,000 horse power at low water. The dam is 400 feet long, and at its deepest part is 50 feet high, raising the water sufficiently to give a head of 150 feet when delivered at the power house erected below the Cascade Falls and distant about 2,500 feet. The water is conveyed in a channel cut in the rock for about 1,100 feet and then through a circular stave-pipe line, 7 feet in diameter and 1,400 feet in length, passing thence through a steel pressure pipe to three direct-connected McCormick turbines each running one Westinghouse 750-kilowatt 3-phase gener-

GENERAL VIEW OF POWER HOUSE, CASCADE WATER POWER & LIGHT COMPANY.

ator wound for 2,200 volts. Two 12-inch turbines operate two 45- kilowatt exciters. Nine transformers raise the current to 20,000 volts, at which pressure it is transmitted over a high-tension circuit of two separate 3-phase transmission lines built from Cascade via Grand Forks and Phoenix to Greenwood, about 26 miles. Sub-stations reduce and distribute the power, at Grand Forks to the Granby Co.'s 2,000-ton smelting works; at Phoenix to the same company's big copper mines, where

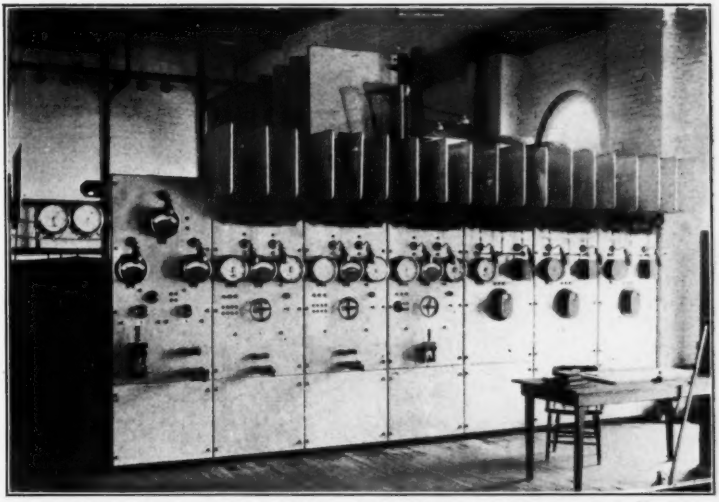
a 60-drill air compressor is operated by two 700-horse-power induction motors, and a large rock crusher by a 100-horse-power motor, and to the Snowshoe mine to run a 150-horse-power electric hoist; and at Greenwood to the B. C. Copper Co.'s smelting works. Grand Forks, Phoenix and Greenwood are all lighted by electricity. The Cascade Co. generates about 2,000 horse power, with one unit in reserve.

Besides utilising power obtained from the Cascade Co., the Granby Co. has its own power house near its smelting works, on the North Fork of Kettle River. The water is brought from a dam, situate about a mile up the North Fork, in a 9 by 12-foot wood flume, and it gives a

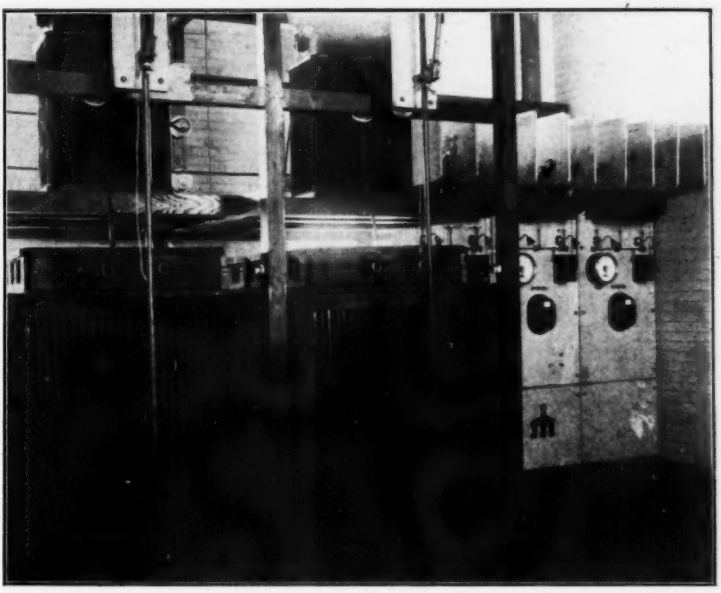


TURBINE INSTALLATION, GRANBY MINES, KETTLE RIVER WATER POWER.
Three pairs 16-inch turbines, one 13-inch and one 10-inch single. Dayton Globe Iron Works.

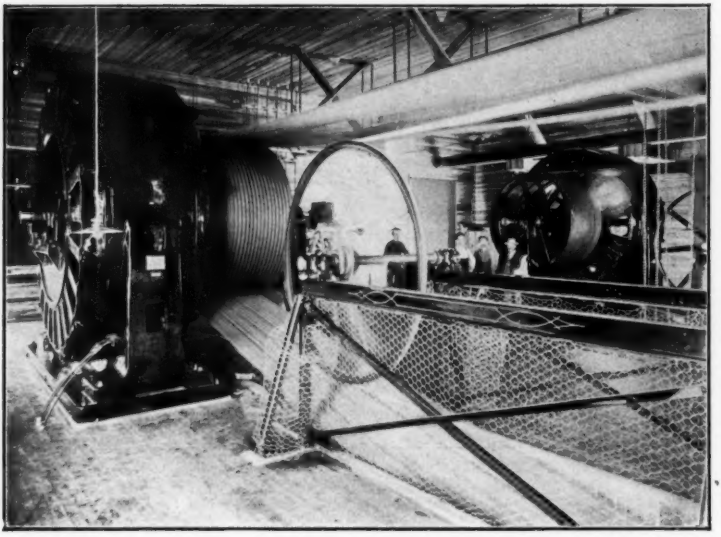
pressure head of 45 feet. The power plant includes four sets of Dayton Globe Works 16-inch turbines, each directly connected to a Westinghouse rotating-armature, alternating-current generator, these together developing 1,100 horse power. Other turbines are belted to Stilwell-Bierce & Smith-Vaile triplex pumps, which pump water for granulating the slag and for the water jackets of the blast furnaces, and for supplying water to the town of Grand Forks.



SEVEN-PANEL SWITCHBOARD, CASCADE WATER POWER & LIGHT COMPANY'S POWER HOUSE, CASCADE, B. C.
Westinghouse Electric & Manufacturing Co.



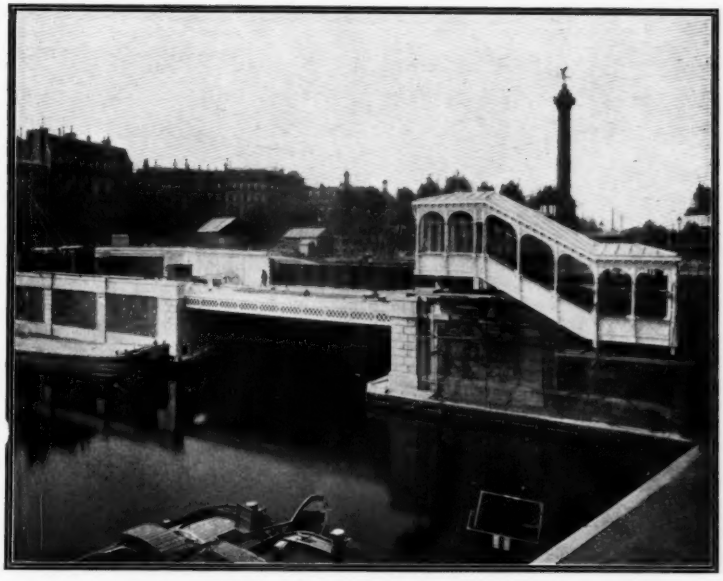
INTERIOR OF SUB-STATION, CASCADE WATER POWER & LIGHT CO. PHOENIX.
Westinghouse Electric & Manufacturing Co.'s machinery.



TWO 700-HORSE-POWER INDUCTION MOTORS DRIVING TWO 30-DRILL AIR COMPRESSORS, GRANBY COMPANY'S MINES, PHOENIX, BOUNDARY DISTRICT, B. C.

Power supplied by the Cascade Company.

The plants mentioned are important, but it is evident that the development of the available power is only in its infancy, and that as the immense mining and lumbering resources of the Province become generally turned to profitable account there will open up a widening field for the skill of engineers and the products of engineering manufactories, of considerable importance. With such enormous latent power as that of the Fraser River, from where it is joined by the Thompson River at Lytton for about 50 miles down to Yale, the head of river navigation, the fall between these two points being nearly 500 feet; that of the Columbia River, also as yet practically unused for power purposes; that of the Kootenay River, from Kootenay Lake (with its estimated area of 141,120 acres) along its 40 to 50-mile course to where it joins the Columbia, and having a series of rapids and falls below Nelson; that of the plunging Elk River, within a short distance of the big coal mines of the Crow's Nest Pass country, besides the available waters of many smaller streams—with such great advantages in association with the possession of illimitable resources in its mines, its forests, and its fisheries, the industrial and commercial future of British Columbia certainly appears to be big with promise.



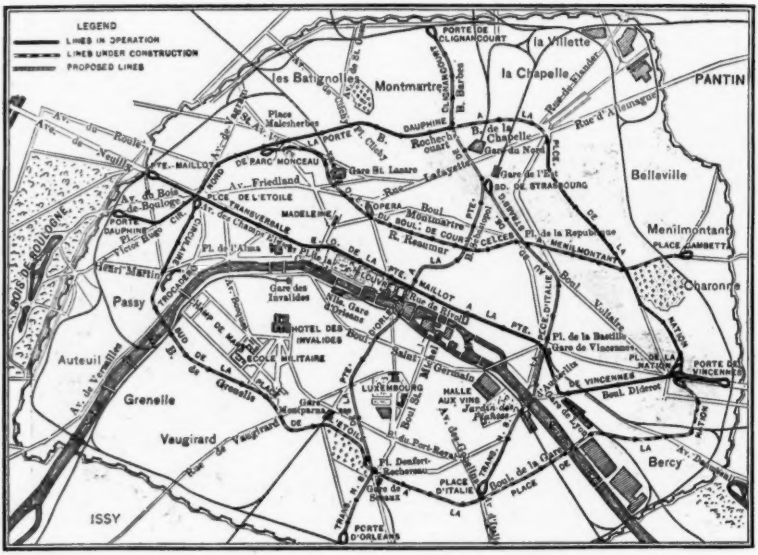
PLACE DE LA BASTILLE STATION, METROPOLITAN RAILWAY OF PARIS.

THE METROPOLITAN RAILWAY OF PARIS.

By Paul Letheule.

Mons. Letheule's article, with its very fine illustrations, is particularly noteworthy just at this time on account of the activity of interest in city transportation. New York and London are facing problems of which every growing city will sooner or later meet a counterpart. Every lesson drawn from actual experience is of value.—THE EDITORS.

THE construction of the Metropolitan Railway System reflects the highest credit upon the engineers and contractors entrusted by the city of Paris with the execution of this important undertaking. The technical staff of city engineers identified with these remarkable works consists of Mr. Bienvenue, chief engineer, assisted by Messrs. Biette, Locherer and Briotet, assistant engineers; Mr. Pollet, chief inspector; Mr. Thomas, and Mr. Hervieu, chief clerk of the board. At first, contractors viewed the undertaking with such utter indifference that the city, being unable to obtain bids on the work, had to build and complete the first section itself. After that, however, interest was aroused, competitive bids tendered, and contracts awarded for the balance of the work at a considerable saving to the city over original estimates of cost.


LEGEND
LINES IN OPERATION
LINES UNDER CONSTRUCTION
PROPOSED LINES
les Batignolles
Montmartre
la Villette
la Chapelle
PANTIN
Belleville
Menilmontant
Charonne
Passy
Auteuil
Grenelle
Vaugirard
ISSY
Bercy
Gare des Invalides
HOTEL DES INVALIDES
ECOLE MILITAIRE
LUXEMBOURG
Gare Montparnasse
Gare d'Orsay
Gare de Lyon
Gare de Bercy
Gare du Nord
Gare St. Lazare
Gare de l'Est
Gare de la Rapée
Gare de Vincennes
Pl. de la Bastille
Pl. de la Nation
Pl. de l'Etoile
Pl. de l'Alma
Pl. Denfert-Rochereau
PORTE D'ORLEANS
PORTE DE CLIGNANCOURT
PORTE DE VINCENNES
PLACE D'ITALIE
PLACE CLICHY
PLACE LAMBERT
Av. de la Grande Armée
Av. Friedland
Av. de Wagram
Av. de Neuilly
Av. de Versailles
Av. du Trocadéro
Av. de Suffren
Av. de Tourville
Av. de Ségur
Av. de Breteuil
Av. de Villars
Av. de la Motte-Picquet
Av. de Choisy
Av. d'Italie
Av. Daumesnil
Av. de la République
Av. de Montsouris
Av. de l'Observatoire
Av. de l'Opéra
Av. de la Bourdonnais
Av. du Bois de Boulogne
Av. Henri Martin
Av. du Trocadéro
Av. de la Grande Armée
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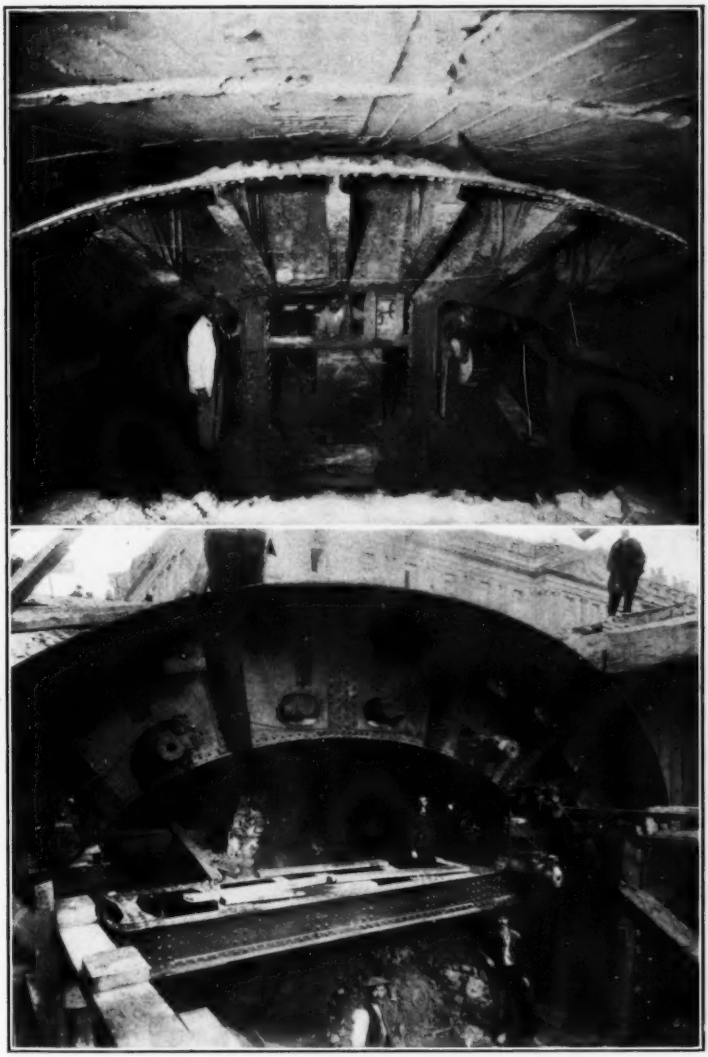
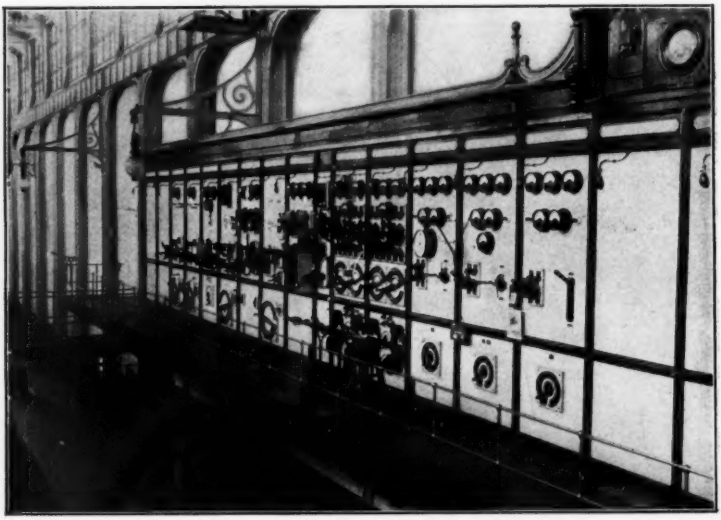
Av. du Bois de Boulogne
Av. Henri Martin
Boul. de Clichy
Boul. de Rochechouart
Boul. de la Chapelle
Boul. de la Villette
Boul. de Strasbourg
Boul. de Sébastopol
Boul. de Magenta
Boul. de Sébastopol
Boul. de Strasbourg
Boul. de la Chapelle
Boul. de la Villette
Boul. de Rochechouart
Boul. de Clichy
Boul. de Courcelles
Boul. de Malesherbes
Boul. de Haussmann
Boul. de Courcelles
Boul. de Malesherbes
Boul. de Haussmann

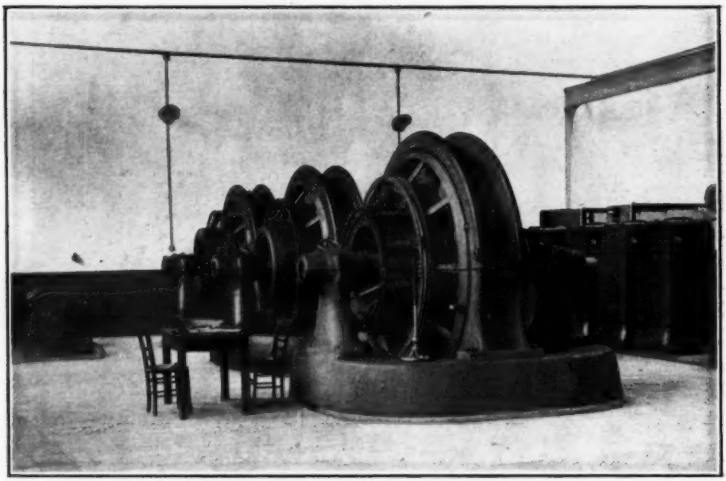


THE UPPER VIEW SHOWS THE FRONT OF THE SHIELD USED IN REGULAR TUNNEL WORK; THE LOWER, THE BACK OF THE SHIELD.

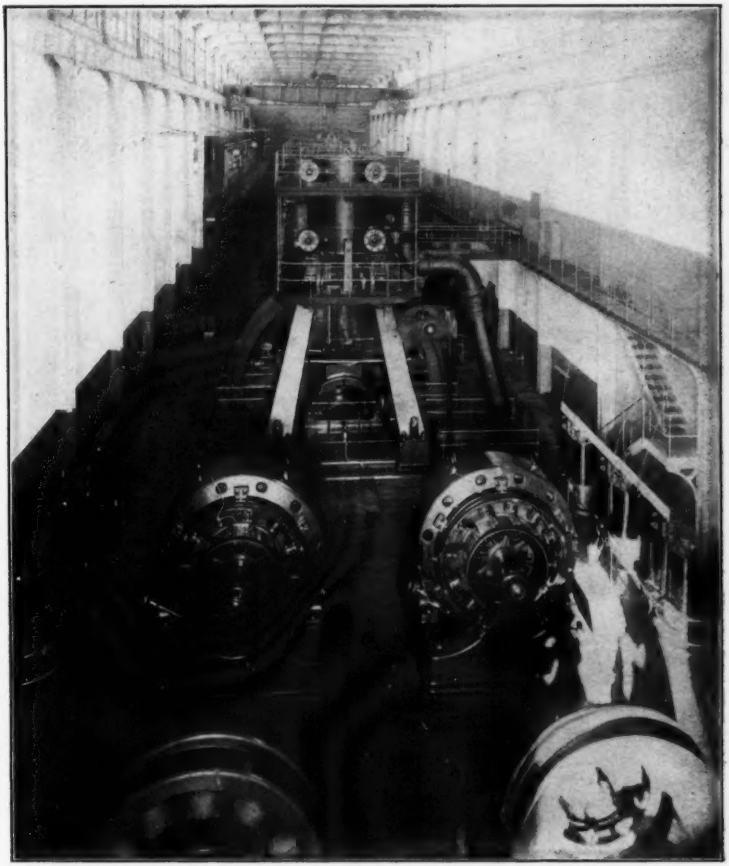


BERCY STATION SWITCHBOARD; THE DYNAMO PANELS.

and the other at Asnières, built by the Société Alsacienne de Constructions Mécaniques, to furnish light and power in the districts of Clichy and Asnières. The third plant belonging to the Metropolitan Railway



GENERAL VIEW OF BARBES SUB-STATION.



THE BERCY GENERATING STATION.

Company is situated at 45 Quai de la Rapée, at Bercy, near the Gare de Lyon Station, and very close to the first line, which it is therefore able to operate economically by direct current. This power house generates both alternating and continuous current, and at present contains the following equipments:—

One 1,500-kilowatt direct current set,
Three 1,500-kilowatt alternators,
Two 750-kilowatt rotary converters and their transformers.

Extensions are being built to make room for these additions:—

VIEWS ILLUSTRATING FIRST AND SECOND STAGES OF THE CUT-AND-COVER WORK.

The upper picture shows the steelwork of the roof in position, before the excavation. The lower shows the completed excavation for a station, with the steel framing of the roof in place.

Two 2,000-kilowatt alternating-current generators, with the necessary engines, boilers, etc.,

Two 750 kilowatt rotary converters.

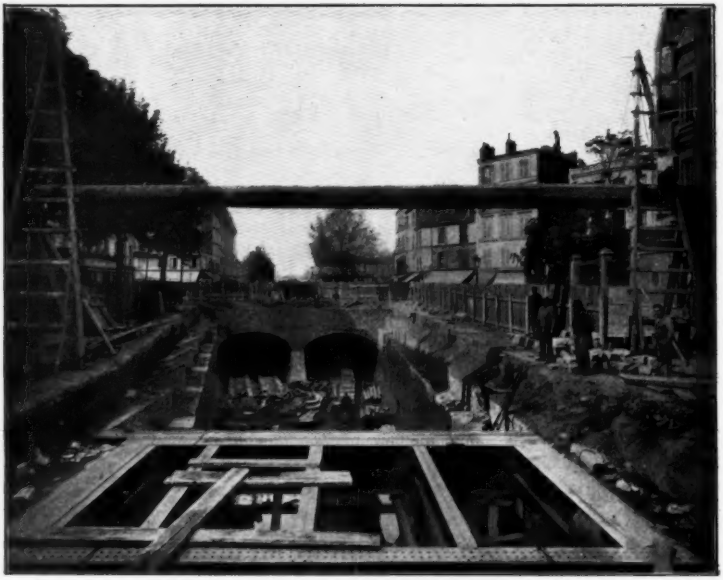
The Moulineaux power house supplies current to the Invalides-Versailles Electric Railway, to the Western Railways Company, and to the Parisian Western Electric Tramway. Its plant consists of twelve-3,500-volt 25-cycle three-phase alternators, two of which are reserved for the exclusive service of the Metropolitan Railway. From these

FINISHING THE COVERING IN, FEBRUARY 1903, OPÉRA STATION.

units, three-phase alternating current is supplied to the Etoile substation. Until quite recently it also supplied the temporary substation at the Champs Elysées which was equipped with two-750-kilowatt units, which will be removed to Bercy to complete the extension above mentioned.

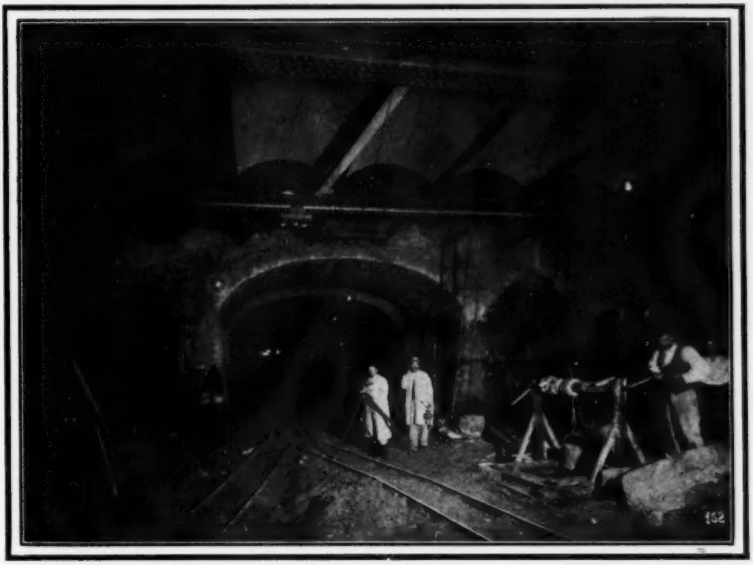
The equipment of the Bercy power house consists of Creusot dynamos driven by Creusot vertical compound engines. The Moulineaux power house, on the other hand, is equipped with Westinghouse alternating-current generators, direct-connected to Corliss engines built by the Dujardin Company, and to Garnier & Faure-Beaulieu engines. The Société Alsacienne de Constructions Mécaniques of Belfort has a contract for installing the steam plant, and the French Thom-

GARE DE LYON STATION. ERECTING THE STEEL ROOF.



BRANCHING POINT ON THE TUNNEL LINE OPPOSITE THE GARE DE LYON STATION.
Showing connection of tunnel with cut-and-cover work.

son-Houston Company, the electrical equipment of the Bercy power house extension. The equipment of the three-phase Asnières power house consists of alternators driven by horizontal engines, all built by the Société Alsacienne de Constructions Mécaniques.

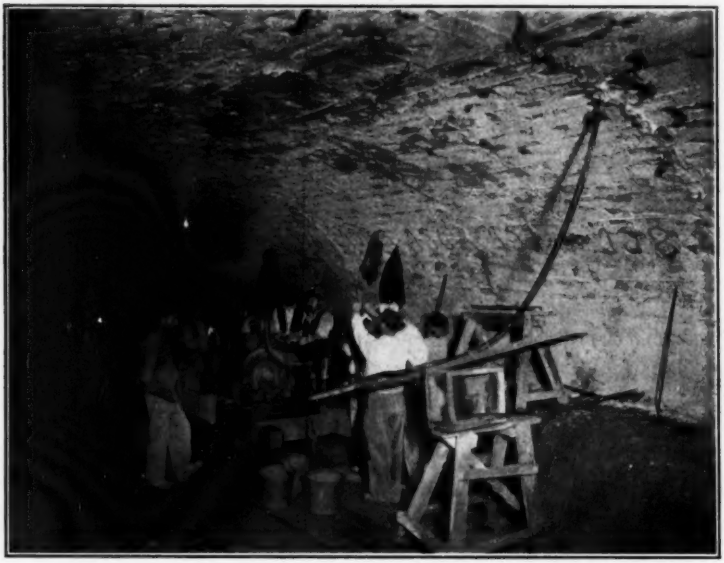


ENTRANCE TO TUNNEL, WITH CUT AND COVER WORK SEEN FROM BELOW.

Interconnections between the different primary lines from the three power houses have been so provided for that in case of an accident at a power house, any sub-station can be connected with any of the other primary lines, thus avoiding any interruption of service.

The distribution of load between the different power houses depends of course upon the demands of the Metropolitan Railway Company's traffic, regulated by economical considerations based upon the actual cost of the Metropolitan's own power house as compared with the cost of power under its contracts with the companies owning the auxiliary plants. It is needless to enter into a detailed comparison of load variations at each power house; suffice it to say that at the present time the total current supplied by the three combined power houses of Bercy, Moulineaux, and Asnières, at a pressure of 600-volts, direct current measured as at the sub-station, is stated to be about 4,700 kilowatts.

The sub-stations are designed on the approved style of construction in the United States; all the transformers and converters have been furnished by the French Thomson-Houston Company, with the exception of two Creusot transformers in the Bercy power house, and three Creusot transformers at the Etoile sub-station.



CONSTRUCTION OF THE TUNNEL. INJECTING CEMENT BEHIND THE ARCH.

In addition to the transforming station in the Bercy power house, which consists of two 750-kilowatt rotary converters in operation, and two 750-kilowatt machines in course of installation, with a direct-current set of 1,500-kilowatt capacity, the following is a list of the sub-stations on the system:—

The Etoile sub-station, containing four 750-kilowatt rotaries, three of which are Creusot machines, and one Thomson-Houston.

The Barbes sub-station, with three 750-kilowatt Thomson-Houston rotaries.

The Père-Lachaise, with three 750-kilowatt Thomson-Houston rotaries.

The Louvre sub-station, with two 750-kilowatt Thomson-Houston rotaries.

Under normal conditions the Etoile sub-station is fed by the Moul-

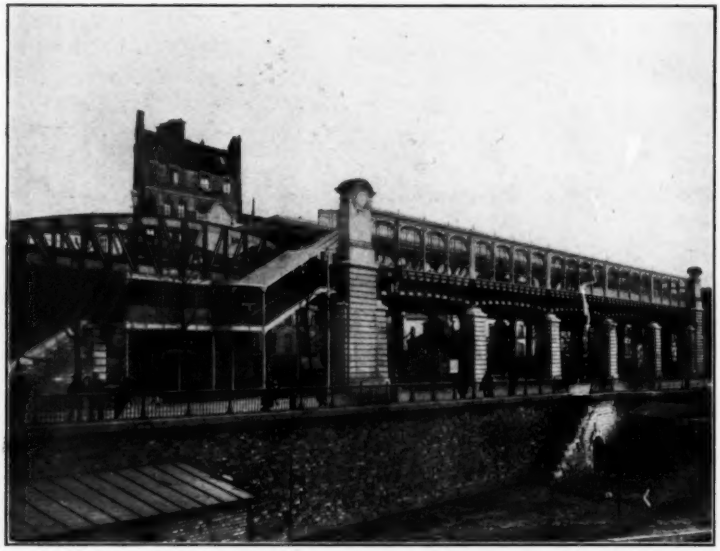
CONSTRUCTION OF THE METROPOLITAN TUNNEL ABOVE THE THREE ARCHES OF THE BATIGNOLLES TUNNEL.

ineaux power house, the Barbes sub-station by the three-phase Asnières plant, and the Père-Lachaise and Louvre sub-stations by Bercy.

The large number of trains in service makes the use of storage batteries unnecessary. A storage battery was originally installed in the Etoile sub-station, which at the time was necessary owing to the few

trains in operation, but with increased service it has been found that they can be entirely dispensed with. To-day the Père-Lachaise station alone is equipped with a 350-ampere-hour storage battery for the sole purpose of insuring a steady light service on trains after stops.

The wiring plan of the primary lines connecting the power house and sub-stations is very complicated and is not yet completely installed. At present the Metropolitan Railway Company is obliged to use, on one section, the cables that were laid for the Exposition of 1900, for the transmission into Paris of the three-phase current from

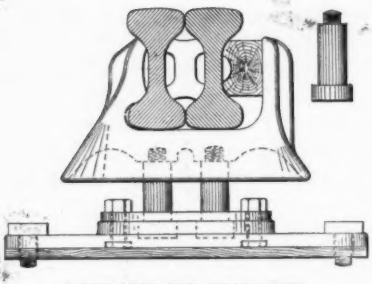


THE RUE D' ALLEMAGNE STATION FROM THE QUAI VALMY.

the Asnières power house and of power from the Moulineaux plant to the sub-station installed at the Quai d' Orsay for the operation of the moving platform and of the little Quai d' Orsay railroad. The main feature of this complicated network of primary wires is the admirable provision made for the interchange of sub-station connections to any of the primary lines, which prevents the possibility of a tie-up on any part of the system due to an accident to any of the power houses. The feed wires carrying direct current from the sub-stations to the third rail are necessarily very short, as the former are all very close to the railway lines. The system is operated throughout by a third rail with track return.

RAISING THE FIRST COLUMNS OF THE VIADUCT, INTERSECTION OF THE BOULEVARD DE LA CHAPELLE AND THE RUE MAUBEUGE.

PLACING THE GIRDERS ON THE COLUMNS OF THE VIADUCT.



INSULATOR FOR THIRD RAIL.
BLACKWELL TYPE.

The third-rail installation differs considerably in the cases of Lines 1 and 2. On Line 1, the insulator, which is of the Blackwell type, supports two conductor rails, as shown in the accompanying illustration. Insulation is obtained through the two supports, as shown, which are covered with an insulating material called "Aetria." On Line 2 the insulator consists of an iron cap covered with ambroine, and supports one single third rail of a special composition. The accompanying illustration shows a cross section of the insulator and rail complete drawn to scale.

On Line 1 the same steel was used in the third rail as in the track rails, but in Line 2 a special third rail was made up of the following analysis:—

Carbon	0.15 per cent.
Manganese	0.55
Sulphur	0.035
Phosphorus	0.016
Silicon	0.06

having 7.54 times the electrical resistance of copper.

On Line 2 the bonds used on the third rail are of the "Chicago" type, 80 centimetres long, four to a joint, and riveted into the web of the rail. On the track, where greater elasticity is required, the bond is formed of strips of copper and its terminals riveted into the foot of the rail. On the track four bonds are used to each joint, the same as on the third rail.

Trains are operated in sections of four and eight cars; in the former case the forward car is the only motor car. In eight-coach trains both the forward and rear cars are motor cars, and can be operated separately or in series from the one controller. On some of the lines it is necessary to run trains with motor cars at both

INSULATOR FOR THIRD RAIL. PARIS METROPOLITAN TYPE.

ends, owing to lack of facilities for switching at terminal stations. Each motor car carries two motors that can be coupled in parallel. In the case of a double-ended train or where two motor cars are to be controlled simultaneously, these coupled motors can be operated in series by means of a connecting cable carried right through the train, and the reversing switches can be electrically controlled from a distance as in the Thomson-Houston multiple units. If it is desired to use only one of the motor cars, the other can be readily disconnected, and the two motors of the one car thrown into series-parallel.

The rolling stock itself is extremely light and all carried on single trucks. The motor cars are all second-class carriages. The trailers, on the other hand, are divided into first and second-class coaches, identical in construction, but differing in the appointments of their interior decoration. These cars are 8.70 metres long, 2.40 metres

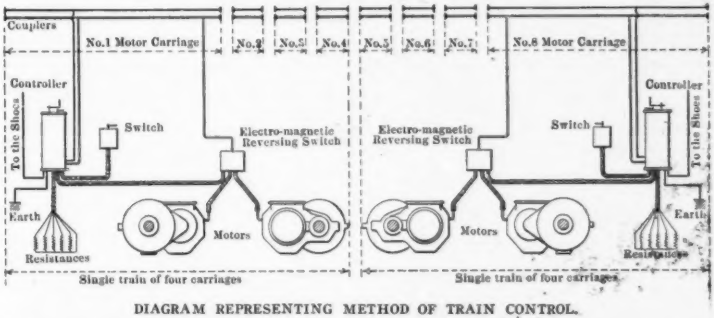


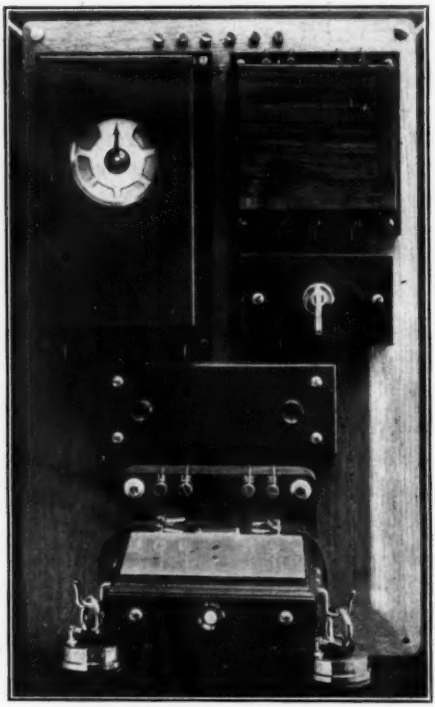
DIAGRAM REPRESENTING METHOD OF TRAIN CONTROL.

wide, and 2.30 metres high, with ten rows of cross seats set back to back, with the exception of the two end rows. A longitudinal aisle cuts through these rows, leaving on one side ten rows of single seats, 0.45 metres wide, and on the other, ten rows of double seats 0.92 metres wide, giving a total seating capacity of thirty passengers. There are two sliding doors on each side of the car, one serving as an entrance and the other as an exit.

The cars are electrically lighted by six incandescent lamps in the ceiling and by four corner clusters. It is proposed to heat the cars electrically, and also to operate electrically a device for indicating the next station ahead. Neither of these improvements has yet been installed, however.

The temperature in the tunnel during the coldest season never falls below 10° centigrade; therefore, in view of the short rides, there is no real necessity for heating the cars.

In order to facilitate the riding of the cars on short radius curves, they are built with buffers at one end only. The end sills are also slotted so as to allow a lateral play to the couplers in going around curves. The road is equipped with the Hall signal system, insuring a safe distance of two electric blocks at a headway of two minutes between trains. A two-minute schedule has off and on been maintained, but it is not kept up at the present time owing to insufficiency of rolling stock.



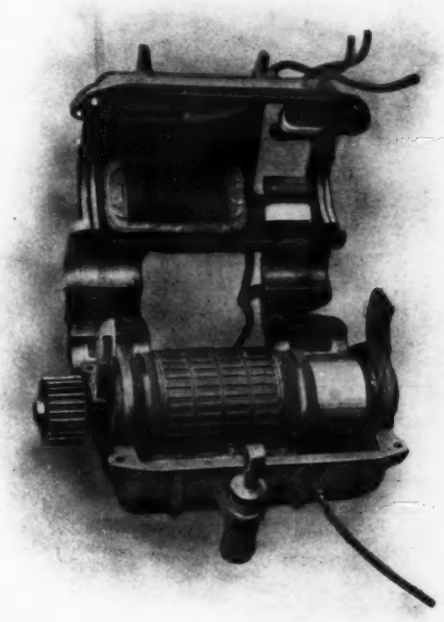
DARDEAU SELECTIVE TELEPHONE SYSTEM.

The subway is lighted throughout by electricity. Clusters of five 16-candle-power lamps each are spaced at intervals of 12½ metres on stations and platforms, and at intervals of 25 metres in the tunnel proper.

All stations, power houses, car sheds and offices are connected with one another by telephone on the Dardeau plan, which consists in connecting the different telephone stations in series on one same single or double line, from each of which interconnections can be effected between stations by means of a mechanical device, something like a clock, in which the turn of the hand or lever toward any given station shown on the dial gives the desired connection. This clock-work mechanism is wound by hand, each full winding providing for two thousand calls.

The car sheds and shops are about as inadequate as the rolling stock itself, additional storage room for cars having only recently been provided under the Place de la Nation Square. All repairs to rolling stock are looked after in the Rue des Maraichers shops, which

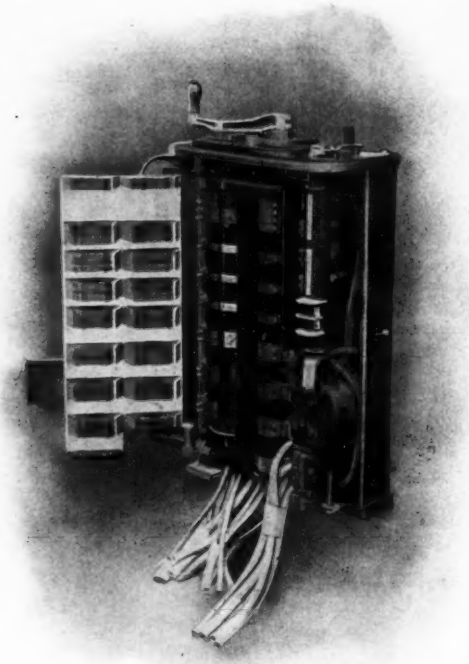
occupy a total area of 11,380 square metres, comprising:—one shed with a floor space of 2,250 square metres, in which are the machine shops containing iron and wood-working machinery, saws, planes, drills, etc., all electrically driven, the foundry, the paint shop, 70 metres of car pits, provided with the necessary cranes and hoists, and also the general offices of the company; a store room, which takes up part of the shed above mentioned and occupies an additional floor space outside of that building of 95 square metres; and a building used as living quarters of the station master and his assistant. The rest of the space is used as a store room for cars with a total trackage of 1,120 metres outside of the main operating tracks, of which 520 metres are under cover.



METROPOLITAN RAILWAY MOTOR

The fares charged on the Metropolitan Railway are francs 0.25 in first-class and francs 0.15 in second-class from any one point to another on the system. Up to 9:00 A. M., the second-class excursion tickets are sold at francs 0.20, the return ticket being good for the return trip at any time of the day or night.

These rates of fare, while comparatively cheap for long rides, are of course high for short distances; this, especially in the case of line 2, permits of a very appreciable competition from the surface road operated by the Compagnie des Omnibus, whose La Vilette-Trocadéro line, operated by steam, parallels the Metropolitan Railway's branch.



THE CONTROLLER, OPENED.

The fares charged on the surface road are francs 0.15 in first-class, and francs 0.10 in second class, with an extra fare of francs 0.05 for long distances.

The Compagnie des Omnibus, which operates the greater part of all the omnibus and tramway lines in Paris, came near losing all their traffic on this line when the Metropolitan Railway inaugurated its service on line 2, but has recently made a bid for public favor and has regained its patronage to a great extent by reducing its fares, by substituting steam for animal traction, by increasing its service from a fifteen-minute to a five-minute headway, and by introducing open cars on its line in place of the old-fashioned motor cars, which were already very much the worse for wear.

MANUFACTURING: CAPITAL, COSTS, PROFITS AND DIVIDENDS.

By Henry Hess.

Among the many contributions of lasting value in the literature of "Production Engineering" which THE ENGINEERING MAGAZINE has had the privilege of publishing, this paper by Mr. Hess is probably one of the most important. It is an extension of the modern scientific study of manufacturing into the province of general commercial management. It applies the results of cost-finding methods to the ultimate questions of profit or loss in production. We are glad to announce that this initial article will be followed during the winter by further contributions from Mr. Hess extending the analysis to the effect of the principal wage systems upon the profits of the business as a whole.—THE EDITORS.

IN order to get and to keep an intelligent oversight of the prospects and progress of any business, the first requisite is a basis of comparison. With a new venture this must needs be an estimate of expenditures and returns; with an already established business, the estimate is supplanted by records of previous experience.

For practically every line the volume of business is more or less proportional to the number of people employed, and, if a commodity is being produced, to the output per productive worker's hour. These two elements, therefore, will serve as the basis for a ready and comprehensive oversight.

A convenient method that also permits quick tracing of alterations in cost of production has been devised by the author and used with decided success and satisfaction; in explaining it a set of values are assumed for a hypothetical plant engaged in the manufacture of a line of special tools. The figures are entirely arbitrary and are not to be understood as serving any purpose other than that of general illustration.

Capital is employed, part of it in providing a plant in which and with which to produce the articles to be made, and a further part in starting the plant into operation; these two items make up what I term Total Fixed Capital. Further capital must be provided to defray current expenses incident to operation of the plant until such time as the returns from the sales render additions to this capital account unnecessary; capital so employed is aptly known as "running capital," and as it varies in amount with the number of productive hours, I prefer the more expressive, if longer, term "total variable running capital per productive hour."

This capital account is carried because profits are distributed as dividends to its total—at least in fact, though not always in name, when water has been diligently poured in to swell the bulk.

The other, and in the conduct of the business far more important main account, is that of costs; of these some are fixed and others again variable with the intensity of the output. The usual practice divides this account into three groups—material, productive labor, and expense—and considers the expense as directly proportional to the labor. Since, unless labor is expended, no material is used, it follows that the material charge also is directly proportional to the labor cost; in other words, if no work were done, no costs would be incurred. Reduced down to this, it is at once evident that the considerations underlying such apportionment are wrong. From this point of view I list as Total Fixed Costs all those items that are to be provided to put the plant in readiness, and as Total Variable Costs per Productive Hour all the remaining elements that may be reduced to a ratio with the productive hours.

The effects of the two points of view may be shown in another way: with all the costs varying directly with the time, they would be zero with a zero production and could be graphically represented by a line (such as that marked Total Variable Costs, in diagram Figure 2) starting from zero; the Total Net Receipts also start from zero; the vertical difference between the two lines represents the profits; thus apparently a profit is shown as soon as production is begun. It is, however, well known that at least a certain amount of production is necessary before a profit can be made. Instead of starting the total costs from zero, start them from point corresponding to the Total Fixed Expense (refer again to Figure 2); the result will be a crossing of this line with the Total Net Receipts line; this crossing will occur over that number of productive hours or men, or that weight of output, required to balance the costs. With a less output the business will be attended by a loss; with a greater output, a profit is to be expected. This matter has been entered into at some length as, though the importance of keeping general expenses down is generally recognized, the usual way of considering them as proportional to the labor leads to wrong conclusions that may, when production is low, give the impression of a margin of profit when actually there is a loss.

Following the tabular arrangement of the accounts given below, with their assumed values, a few further general considerations governing the apportionment of items of cost are given, more with a view to illustrate principles than to serve as a full enumeration.

Main Heads.

Costs		*Capital*	
Plant expense	$21,250	Plant	$179,200
To start plant	11,100	To start plant	11,100
Total fixed costs	$32,350	*Total fixed capital*	$190,300
Indirect expense per productive hour	$ 0.175	Indirect running capital per productive hour	$ 0.044
Direct expense per productive hour	$ 0.405	Direct running capital per productive hour	$ 0.101
Total variable cost per productive hour	$ 0.580	*Total variable running capital per productive hour*	$ 0.145

Detail Items.

		Real estate	$ 10,700
Building depreciation	$ 8,300	Buildings	55,300
Machinery "	10,300	Machinery	103,000
Pattern "	650	Patterns	2,600
Small tools "	900	Small tools	4,500
Interest, taxes, insurance	1,100	Interest, taxes, insurance	1,100
Total plant expense	$21,250	*Total plant capital*	$179,200
Initial commercial staff	$ 2,500	Initial commercial staff	$ 2,500
" engineering staff	1,500	" engineering staff	1,500
" power, light, heat	1,600	" power, light, heat	1,600
" unproductive labor	1,100	" unproductive labor	1,100
Unproductive material	1,400	Unproductive material	1,400
Advertising	3,000	Advertising	3,000
Total starting expense	$11,100	*Total starting capital*	$11,100
Balance commercial staff	$ 0.033	Balance commercial staff	$ 0.008
" engineering staff	0.040	" engineering staff	0.010
" power, light, heat	0.027	" power, light, heat	0.007
" unproductive labor	0.053	" unproductive labor	0.013
Foremen and assistants	0.022	Foremen and assistants	0.006
Total indirect expense per productive hour	$0.175	*Total indirect running capital per hour of productive labor*	$0.044
Productive labor	$ 0.180	Productive labor	$ 0.045
" material	0.225	" material	0.056
Total direct costs per productive hour	$0.405	*Total running capital per productive hour*	$ 0.101

More or less latitude is necessarily given in the apportioning of the items to these groups. The distribution should be decided on as early as possible and then adhered to; this is more important than splitting hairs as to whether some item falls more logically under one head than another; changing about will vitiate all conclusions to be drawn from comparisons, and comparative analysis is the very essence of cost reduction. Above all things, the creation of an account or sub-head for miscellaneous charges is to be avoided; in time such a head invariably swells out of all reason and becomes a catch-all for all items that, by stretching a point, may be excluded from some group that needs a little phlebotomy to appear less apoplectic.

The various items cited are apportioned to the main heads under certain broad considerations that apply to costs as well as capital:

Fixed Costs or Capital:—Incurred or to be provided whether the plant runs or not; divisible into sub-heads, as:—

sums due to laying down the plant, even though it is never started;

sums required to start the plant into operation.

Variable Costs or Capital:—Incurred or to be provided during the operation of the plant, and varying proportionately to the number of productive hours or to the output; divisible into:—

sums not directly chargeable to individual details of actual output, i. e., indirect expense;

sums directly chargeable to individual details of the actual output.

Productive hours refer to the time of the productive men—those actually employed on work that appears visibly in the final output. The term is really a misnomer, as it implies that workers of all other kinds are unproductive, a stigma that is decidedly undeserved, as such other workers are fully as indispensable as any to the furthering of the work as a whole; the term is in such general use that to substitute some other more in accord with the realities, would lead to confusion.

As not all the material used is visible in the final product, all not so visible is by analogy termed "unproductive" and therefore chargeable to the "indirect" accounts, while all that is weighable in the final product is charged as "productive" to the "direct" accounts.

The diagram, Figure 1, gives a comprehensive oversight of this grouping. The final detail items here given may be, and in most lines of work should be, still further analyzed; the farther such division is carried the more readily can an undue accretion of cost be located and corrected. Some caution in this respect is necessary to avoid carry-

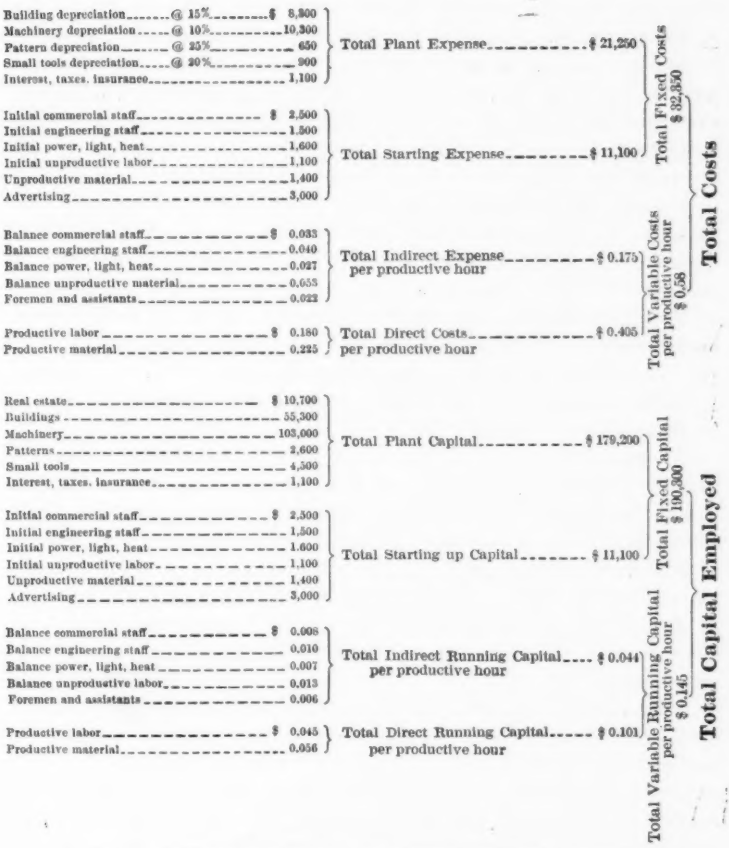

Building depreciation @ 15% $ 8,300
Machinery depreciation @ 10% 10,300
Pattern depreciation @ 25% 650
Small tools depreciation @ 20% 900
Interest, taxes, insurance 1,100
Total Plant Expense $ 21,250
Initial commercial staff $ 2,500
Initial engineering staff 1,500
Initial power, light, heat 1,600
Initial unproductive labor 1,100
Unproductive material 1,400
Advertising 3,000
Total Starting Expense $ 11,100
Total Fixed Costs $ 32,350
Balance commercial staff $ 0.033
Balance engineering staff 0.040
Balance power, light, heat 0.027
Balance unproductive material 0.055
Foremen and assistants 0.022
Total Indirect Expense per productive hour $ 0.175
Productive labor $ 0.180
Productive material 0.225
Total Direct Costs per productive hour $ 0.405
Total Variable Costs per productive hour $ 0.58
Total Costs
Real estate $ 10,700
Buildings 55,300
Machinery 103,000
Patterns 2,600
Small tools 4,500
Interest, taxes, insurance 1,100
Total Plant Capital $ 179,200
Initial commercial staff $ 2,500
Initial engineering staff 1,500
Initial power, light, heat 1,600
Initial unproductive labor 1,100
Unproductive material 1,400
Advertising 3,000
Total Starting up Capital $ 11,100
Total Fixed Capital $ 190,300
Balance commercial staff $ 0.008
Balance engineering staff 0.010
Balance power, light, heat 0.007
Balance unproductive labor 0.013
Foremen and assistants 0.006
Total Indirect Running Capital per productive hour $ 0.044
Productive labor $ 0.045
Productive material 0.056
Total Direct Running Capital per productive hour $ 0.101
Total Variable Running Capital per productive hour $ 0.145
Total Capital Employed

FIG. I. GROUPING OF INDIRECT AND DIRECT PRODUCTION ACCOUNTS.

ing the division to a point that gives the general impression of pettifogging to those whose duty it is to look after the apportionment of the items; once that idea takes root it will be almost impossible to enforce that consistent and conscientious apportionment that alone permits an analysis of value.

Most of the items enumerated are self-explanatory. Depreciation ought, if strict logic were followed, to be at first taken as a small portion of the total value of the plant and to be increased with each succeeding year as the wear and tear or general progress in the arts

brings the plant components nearer to the end of their useful life. It is, however, more convenient to adopt a constant percentage, and this is also the more generally observed method. The ratio of depreciation should not be the same for all portions of the plant, but should vary with the probable average useful life; 15 per cent. for buildings, 10 per cent. for machinery, 25 per cent. for patterns, and 20 per cent. for small tools, are fair values. Many of the very strong European firms adopt the policy of practically "writing off" the value of their machinery, patterns, and small tools, or of carrying them on their books at valuations that merely ensure the presence of an account. The effect is a decrease in the nominal assets with, on the other hand, a very decided strengthening in the character of those assets that tend to improve that intangible, but none the less very real, asset of public confidence and credit.

That the capital employed to start the plant into operation is equal to the expense attending starting up is very evident.

As those items that vary directly with the output are incurred only as such output is produced and are again brought in by the sale of that output, the capital employed for these need not be equal to their annual sum total. Assuming that payments are made on an average of three months' time, the sum actually to be provided as running capital will not be greater than one-fourth of these annual expenses.

The usual practice values material on the basis of its weight, and labor and expense on the basis of the labor cost per hour; as the costs are so incurred this is logical. But total costs are made up of the sum of material and of labor and expense. For the purposes of the method of analysis to be set forth, the total as well as detail costs are compared and referred to the output, making their reduction to some common denominator necessary; that may be either their value referred to productive hours or to quantity of output; either form may be used as may be most convenient. If charges based on time are the more important—as in the production of most machines—it will be best to express costs as values per productive hour; but as many will find the reference to weight of output more convenient, both scales are used in the diagrams. In order to avoid large figures, productive men are substituted for productive hours on the basis of 3,000 productive hours per year equalling one productive man. In reducing material to values per productive man, it is assumed that experience has shown the average output per productive hour to be 9 pounds; this, at an average cost of 2½ cents per pound, makes the average cost of productive material per productive hour equal $0.225.

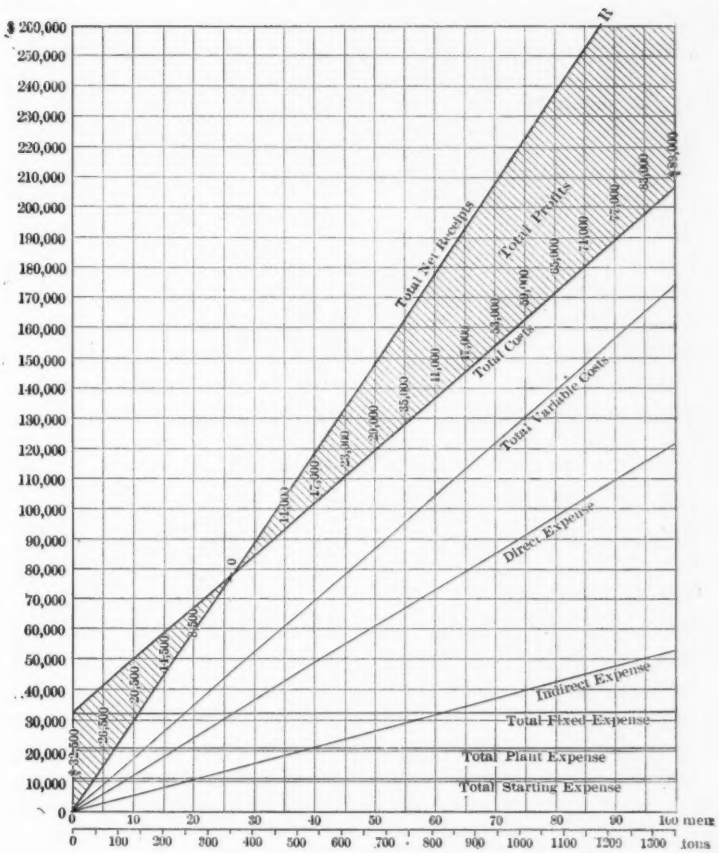


FIG. 2. COSTS, RECEIPTS, AND PROFITS.

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Plotting the various values tabulated above in relation to total productive hours, or rather productive men employed, counting 3,000 hours per man per year, as explained, will give a clearer insight into their mutual relation than can readily be obtained from the same figures marshalled in tables; see Figure 2. The thin horizontal lines are the Total Plant Expense, the Total Starting Expense, and their sum, the Total Fixed Expense. The slanting lines starting from zero are the Indirect Expense, the Direct Expense, and their sum, the Total Variable Cost. The sum of all of these costs is represented by a line start-

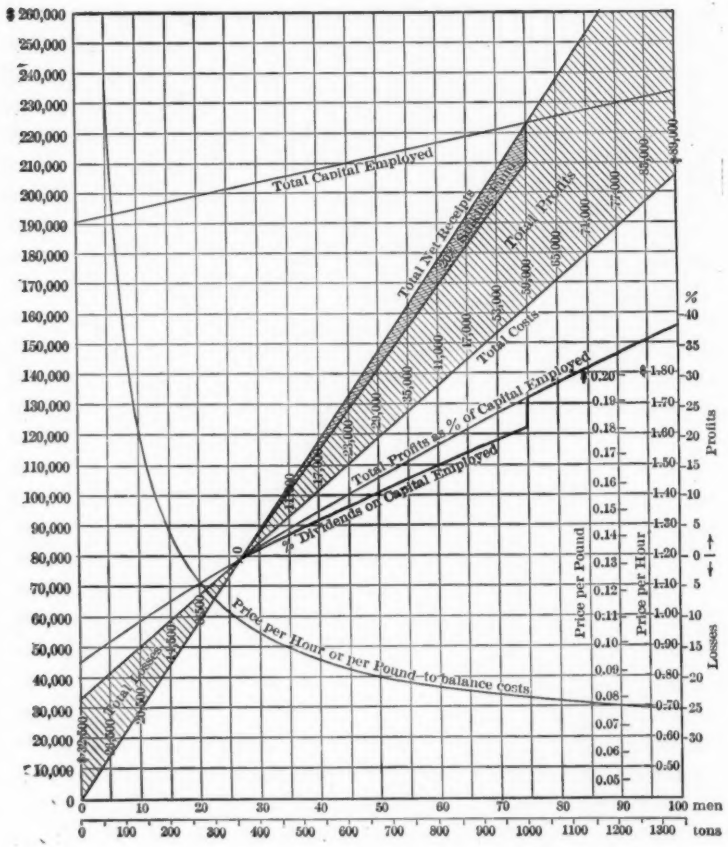

FIG. 3. CAPITAL, PROFIT, AND DIVIDENDS.

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ing from the sum of the fixed costs at $32,350 and running parallel to the sum of the total variable costs.

The output is sold at an average price of $0.11 per pound, and as the average output per man is 9 pounds per hour that means that the net selling price per productive hour is $0.11 \times 9 = \$0.99$. The resultant total net receipts are represented by the heavy slant line. This line crosses the Total Cost line at 26 men, which indicates that at least 26 productive men must be fully employed if no loss is to result.

For any given number of productive men the prospective profit

or loss is the vertical height of the cross-hatched surface. Thus for 50 men the profit is about $29,000; with but 15 men there would instead be a loss of about $14,500.

Such a diagram having values plotted in accordance with previous business results becomes very useful in forecasting probable profits or losses. For that purpose only it will be better to simplify it by copying in only the Total Cost and Total Net Receipt lines, Figure 3. As to many persons the weight of the product is a more familiar factor, a corresponding scale is added to the diagrams on the basis before used of 9 pounds per productive hour, reduced to short tons. This diagram then shows how many tons must be sold, or how many productive men must be kept employed, to pay expenses or to realize any desired profit. Writing in the profits and losses for each output, as shown, adds to the convenience of reading.

The various totals of the capital group are reproduced graphically in Figure 4; as the arrangement is quite similar to that already described in connection with the costs, no further explanation is needed.

The line representing Total Capital is entered also on diagram Figure 3; its crossing with the Total Net Receipts line shows that the total net receipts equal the total capital when 76 productive men turn out 1,030 tons of finished product.

Whether profits are good or poor will depend upon their ratio to the capital required to produce them, i. e., the dividends they represent; their relation to the capital is represented graphically by the line marked Total Profits as per cent. of Capital employed; see Figure 3. Were the entire profits distributed as a dividend, this same line would represent the amount of such dividend; it is zero at the point where the Total Cost and Total Net Receipts lines cross—when the works employ 26 productive men and turn out about 350 tons of finished product. A smaller force or output will result in a loss. With orders in prospect of about 1,030 tons, sufficient to keep 76 productive men employed, the dividend would be about 27 per cent., while the Total Net Receipts would balance the Total Capital Employed. With sufficient orders to employ 100 men the dividend would rise to about 38 per cent. on a total capital increased by only $12,000; this is less than the absolute increase in profits of $30,000. The diagram illustrates in a forcible manner the decided advantage of an active output in improving the dividend. Of course the same increase cannot go on indefinitely, as there comes a point when the production of a larger output is possible only by the provision of enlarged facilities and a corresponding capital increase.

It is not usual or good business to apply the entire profits to dividends, but first to reserve a sinking fund; the simplest arrangement diverts to this fund a definite fraction of the total profits; very often, after the fund has reached a certain height it is simply maintained at that height, leaving all profits beyond to be distributed as dividends. Say that 20 per cent. of the profits are devoted to the creation of a sinking fund up to a total of $12,000, which is 20 per cent. of $60,000; that portion of the profit surface of the diagram Figure 3 that is double-hatched includes the sinking fund; the single-hatched portion indicates the remaining profits available for distribution as dividends. Up to the time that the sinking fund is no longer increased the dividend is less than the total profit; beyond that the two are equal. The heavy line marked o/o Dividends on Capital Employed gives the latter for any number of productive men or tons of finished product. These figures are all based on the actual capital employed; if the nominal capital is larger the dividends on that nominal capital will of course be proportionately smaller.

In times of very close competition, or indeed always, it is useful to know what average price must be realized to balance the costs. It is evident that when the number of men employed is small the cost must be relatively high and, *vice versa,* a large force is attended by a relatively small cost. The curve drawn in on the diagram Figure 3 shows this very clearly; for instance, with a force of 90 men turning out about 1,220 tons, $0.70 per hour or $0.077 per pound will barely cover the costs, but it takes $0.94 per hour or $0.105 per pound when there are in hand orders for only 400 tons, enough to employ the smaller force of 30 men.

All that has been said so far applies to the forecasting of the results of an existing business or of one to be established; but the methods are useful also for following up costs in detail and for pointing out the essential relation and importance of the various elements of cost and so showing where effort must be applied to bring about those economies that count most.

Forecasting is quite useful, but far more important is it to make sure that results agree materially with such forecasts and to find the causes for whatever divergencies there may be. For this purpose the lines laid down in the diagrams may be considered as scales by which actual results are measured. There is nothing new in the idea of following up costs in detail and by groups and comparing these with some ideal; rarely do the results agree with that, and very often are discrepancies attributed to the influence of a fluctuating output; there

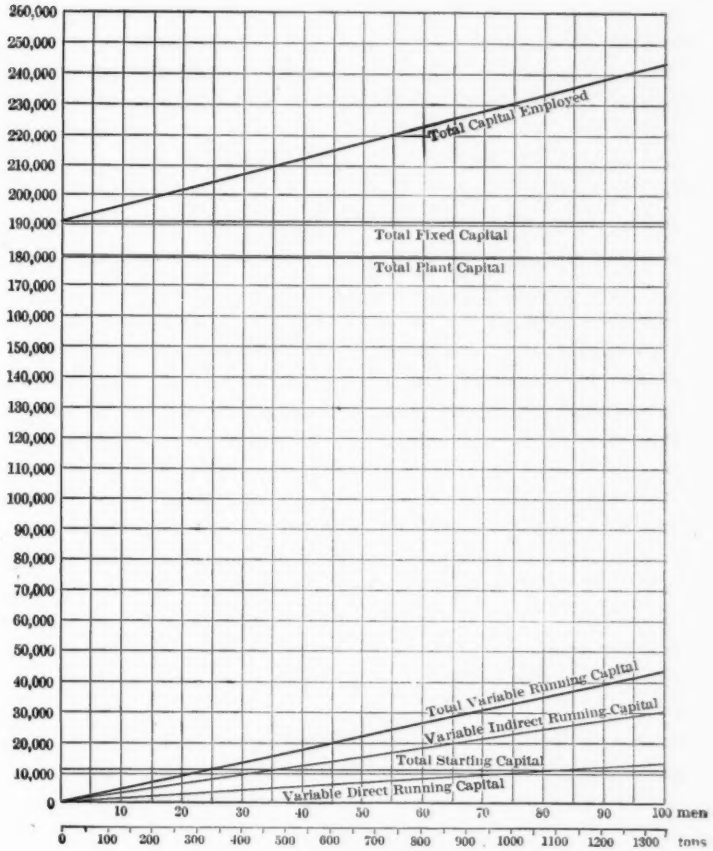

FIG. 4. CAPITAL EMPLOYED.

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is generally just enough truth in that excuse to prevent the responsibility for a falling off being definitely located, owing to the haziness of knowledge of the actual influence of such fluctuation. Since with lines as here laid down the costs are entered vertically over the output weight or number of productive men employed, the influence of fluctuation is considered and eliminated as a disturbing factor in the costs. The diagram Figure 2 might be employed for this following up of the costs, but for the fact that the small scale of the vertical values renders close reading too difficult. A couple of items of cost are used in illustration of the principle and entered on a diagram, Figure 5, to a larger

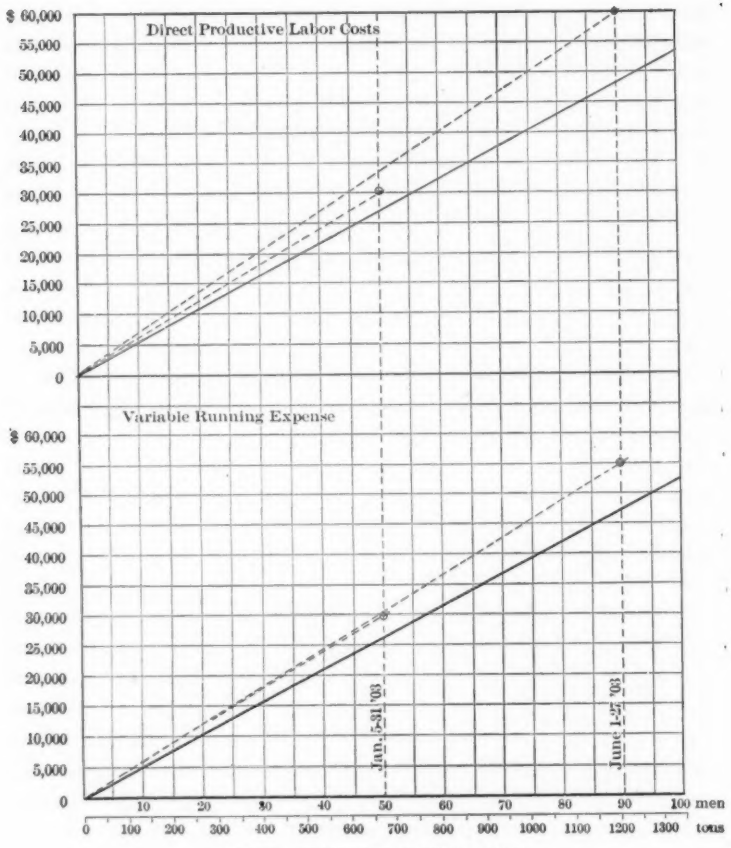

FIG. 5. IDEAL AND ACTUAL COSTS.

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scale; in order to avoid confusion of entries it is desirable to have but one line on each portion of the diagram. The variable running expense and the direct productive labor costs have been selected in illustration. Entries for comparison should be made at regular and frequent intervals of time, say once each four weeks, and not later than the third day of the first week of each period; four weeks, rather than a month, is suggested as the better period to avoid the influence of the varying number of working days per month. Either the weight of output or the number of productive men during the time under consideration is used on the horizontal scale; the number of productive men is the

total number of productive hours worked divided by the normal number of productive hours per man in four weeks; thus 4,800 hours at 60 hours per week, or 240 hours in four weeks, gives 4,800 ÷ 240 = 20 productive men. Say that from January 5 to 31 there were 50 productive men employed, and from June 1 to 27 there were employed 90 men; vertical dotted lines from these numbers are carried over the diagram and marked with the date; on these lines there are entered the actual costs for these periods. A glance shows that the desired results were not reached during either period; as all of the entries fall above the lines, they indicate too high costs; moreover, light lines drawn from the actual results to zero show that the results in June were decidedly inferior to those of January, with the difference not so large for the variable running expense as for the direct productive labor. It may be that this indicates that the larger number of men employed during June is too great for the existing shop staff; but whatever the cause, this falling out of line calls forcible attention to the need of a search for that cause. In cases of notable divergence, either of deterioration or improvement, it is well to enter opposite the entry the reason for such divergence; with time such entries form a very valuable aid to the reduction of costs.

Nor need a search for the reason of a divergence be a difficult or blind one; carrying out the principles laid down, using further comparative lines for the various sub-items of cost, will readily locate those items responsible for the change. Nor is it necessary to start out at once with a very large set of detail items; rather will it be advisable to begin with groups, carrying the analysis of such groups into detail as the need for investigation develops. A useful arrangement brings the whole series of comparative diagrams vertically in line, as shown in Figure 5; this allows the record for a given period to be followed up very quickly by tracing along the vertical dotted line marked with the date to see where wide departures occur.

The work involved is not great, consisting merely in the arrangement shown of data already in existence; this can be readily done by the ordinary office force; but it will greatly aid the always busy and usually overworked man at the helm to a more comprehensive and accurate survey of the entire working of all the various departments, to a correct appreciation of their interrelation and interdependance, and to the location of the responsibility for good and poor results, with less work on his part than any other method I am familiar with. It is applicable to any line of business or manufacture, whether on a large or small scale, so long as the operation can be reduced to comparison with some general factor, such as output or labor.

THE TRAINING OF APPRENTICES IN AN ENGINEERING WORKS.

By C. E. Downton.

According to many well informed and serious thinkers, one of the very pressing problems in modern industry is the supply of proper recruits to the ranks of the workers. In the rapid changes of the last few years the old order of apprenticeship and training has been of necessity discarded, while as yet little has been done toward supplying its place. There is therefore especial value in the study of the systems which have been devised to meet the new conditions, by a few of the farthest and clearest sighted managers, and we hope to follow Mr. Downton's account of the Westinghouse methods by like descriptions of the systems of some of the most successful works in allied engineering lines.—The Editors.

WE have to revert only to the beginning of the last century to find the arts buried in empiricism and the sciences just emerging from a state of probation. Active minds, however, naturally inclined to be analytical, were already collecting data and establishing the laws of cause and effect, and it was not long before the sciences, developing a practical value, became incorporated in the industrial arts and the latter began their wonderful advance which has separated the nineteenth century from the past by a gulf too broad to be spanned even by the most comprehensive imagination.

In this marvelous development, there came into existence the technical school, and from its rapidly expanding doors there has gone out into the ever widening field of industry a vast army of workers, each of whom has been more or less efficiently equipped for participation in the progress that has marked as an epoch the time referred to.

From a careful observation of the qualifications of these men and a study of the methods of their preparation for active service, there gradually evolved a consensus of opinion among pedagogues that there must be a blending of theory and practice to bring about efficient achievement; yet how this blending should be most successfully accomplished still is, and for many years to come will continue to be, a prolific source of fruitful discussion.

Many men who started in the ranks of labor, appreciating their deficiencies, later took courses in the technical schools and, thus fortifying their lines of weakness, have quickly mounted the ladder to fame and fortune. Others who had in early life laid a broad founda-

tion to their education in the classical and technical schools, later began at the lowest rounds of that same ladder and by their superior mental equipment have distanced in a comparatively short interval those with whom they were competing in the race for preferment.

The technical schools, recognizing the benefits that would accrue to their students from a systematic combination of theory and practice, have introduced systems of manual training in their courses with more or less successful results, depending upon their individual conception of the idea and the practical application of its principles.

On the other hand, however, industries developed more rapidly than recruits to their ranks could be provided by the technical schools. In fact, a natural sequence of events required the new vocations to develop to a certain degree before the technical schools could recognize their existence and prepare to educate students for participation in them. Thus has come about a return to the system which existed before the advent of the technical school, where an industry gained accession to its ranks by giving instruction of its own to those who desired to enter its special field of activity.

In the days when empiricism swayed the arts, their secrets were transmitted from father to son or from man to boy through a long and tedious course of training, which finally became systematized into courses of apprenticeship of a certain number of years' duration. The adaptation of this system to our present industries takes into account the strides which have been made in modern systems of education, in which the fundamental principles of the sciences have been incorporated and thereby the time of service has been much abbreviated.

Among those industries which have required a rapid augmentation of their forces, much thought has been devoted to the development of a modern system of apprenticeship. There has been an earnest effort born of necessity to prepare young men so that they may be fitted to fill competently vacancies that occur from time to time in their working organization.

The continued efficiency of any industrial enterprise is dependent to a great extent upon the degree of intelligent familiarity with the nature of the product and skill in methods of manufacture, which is possessed by those employed in the operations necessary to fabricate the finished output. Although the technical schools are doing a commendable service in turning out great numbers of students technically and scientifically trained, still the latter seem to be deficient in that degree of working knowledge that qualifies them to be of immediate use in the industrial organism. It is in the nature of things

beyond the scope of any university to supply the practical experience which will mature men for efficient service immediately upon leaving.

The conditions under which students are given their shop training at college are far from those actually existing in commercial practice. Such training can at best be elemental in preliminary preparation for any of the various lines of industry which the many students may eventually select. At this early stage of his development, a boy has very vague ideas regarding the particular branch of work for which he has a natural taste and aptitude, and the college work, being of a primary nature, is not of much service in aiding him to determine whether he has special qualifications for pure engineering, for constructional design, or for executive management.

It is generally conceded, therefore, that college work should be supplemented in the industrial field by some sort of an apprenticeship service which will give the graduate, under the most favorable environment, a systematic training in shop methods and familiarity with the practical uses of materials. Actual work in the shops of a commercial enterprise also affords an opportunity to learn how men are handled. This kind of experience can only be obtained by becoming part of the organization and being subject to its routine discipline. By entering into active service fresh from college, while the mind is alert and impressionable, the graduate is qualified to work with a degree of appreciation far beyond that of the novice who has had no technical training. His senses are keen, and, by observation and actual performance, he is able to absorb a great amount of information in a very short time. Every operation is easily grasped, owing to his familiarity with scientific data and technical theory, and his ambition is inspired to prove that his knowledge can be of service.

There is no line of modern commercial activity which has developed as rapidly as the electrical industry, and it is here, therefore, that there has been a great necessity for an apprentice system, to serve as a source of admission to its ranks. I have been so fortunate as to have been identified with the development of such a system in the works of one of the largest and most progressive companies in this line, and the methods of instruction there adopted may be considered as fairly representative of the result of the best thought put into effective operation.

Prior to January 1896 there was no regularly organized apprenticeship system in vogue at these works. From the young men who then entered the shops to learn the practical side of the business, no requirement was exacted in advance as to specific qualifications for the

work they were about to undertake. Technical graduates and others were treated exactly alike as far as the course of shop training was concerned. No systematic schedule existed for transferring an apprentice from one department to another. The number of departments through which an apprentice would pass in a given time was dependent largely upon his degree of liking for a certain class of work and the impatience evinced to leave it, or the desire shown to continue in it.

This arrangement was haphazard in its working and did not, of course, insure to either the apprentices or the company the very best results. Ability was not always recognized as the qualification necessary for advancement, as it should have been, modesty, a characteristic which is often associated with ability, frequently acting as a detriment.

Later, as the works grew in size and the number of apprentices increased proportionately, a more efficient organization was established and a separate department formed for the purpose of keeping track of their welfare, and the results so far have proved very satisfactory.

There are now two distinct courses, one for non-technical and the other for technical graduates. The first has been named "The Ordinary Apprenticeship" and provides for intelligent young men who desire to learn the machinist's trade. It is the object of the company to train, from those who take this course, men skilled as mechanics, foremen, and inspectors. This class of apprentices does not progress through the works from one section to another, for it is not intended to give them a general knowledge, but rather a specific training in the manufacture of a definite line of work. Each is put at that class of work for which, after close inspection, he shows himself to be best adapted, and, with the possible exception of about six months spent in the drawing room, remains there throughout his entire course. Each of the sections referred to is practically a complete machine shop, fully equipped with all kinds of tools, which in character are similar to those of the other sections, but vary in size, owing to the difference in dimensions of the product manufactured. The character of experience obtained in any one of them, therefore, yields an acquaintanceship with a general line of shop practice.

This method of treatment has been found to work well with this line of apprentices, for the reason that the individual not only becomes familiar with the various machine tools, but works under the most favorable conditions through a long and constant association with the same men and foremen who know his capabilities and take a continued interest in his welfare. He here passes through a course of filing and chipping, and then progresses to the operation of machine

tools, beginning with the drill-press and taking up in turn the shapers, lathes, planers, and vertical milling machines, finally arriving at armature winding, armature-core building, and assembling of parts and complete machines.

Thus at the end of his apprenticeship service, he is prepared to accept almost any responsibility that would fall to the lot of the skilled mechanic, and, through his perfect identification with the section and his familiarity with his surroundings, becomes inspired with that confidence which is necessary to place a man at the best.

In some cases where special qualifications are shown, through application and study, apprentices are given opportunities in the testing and engineering departments.

A trial period of 685 hours, or approximately three months, is required before the apprentice is allowed to become indentured. During this time he has an opportunity to study the situation thoroughly and is able to come to an intelligent conclusion as to whether he will pursue this calling as his life's work, and it also gives the company a chance to decide whether he is desirable timber upon which to spend time for further development.

The minimum age limit for entering this course is seventeen years, and the compensation and length of service are as follows:

Years in Course.	Hours per Year.	At 17 Years.	At 21 Years.
1st First 3 months	685	5 cents per hour	5 cents per hour
1st Last 9 months	2,055	8 " " "	10 " " "
2nd	2,740	10 " " "	12 " " "
3rd	2,740	12 " " "	15 " " "
4th	2,740	15 " " "	

The apprentice is paid time and one-half for all overtime, and if he completes his course to the satisfaction of the company, is given as a gratuity one hundred dollars and a diploma.

Precedence for vacancies in the corps is given to young men in the works who desire to learn the machinist's trade. At the present time, the number of applicants from this source exceeding the vacancies that occur, access to the corps is closed to those not employed in the works.

Another course, called the "Engineering Apprenticeship," provides for young men who are graduates of technical schools and universities. This is of 5,616 hours, or two years duration, 16 cents per hour being paid for the first 2,808 hours, and 18 cents for the remainder. A trial term of 685 hours is required before acceptance in this course, as in the case of the ordinary apprenticeship, a system of in-

ENGINEERING APPRENTICES AT WORK IN THE ARMATURE-WINDING DEPARTMENT.

denture being in force thereafter. Great care is taken in the selection of men for this work. Every endeavor is made to obtain the highest class of graduates from the leading technical schools; the co-operation of the professors is solicited, and their recommendations are given careful consideration before the applicant receives any encouragement.

Application blanks must be filled out in the hand-writing of the applicant, giving name and address of the father or mother, or if they are deceased, of guardian; also the date of birth of applicant and the names and locations of schools attended, with a statement of the nature of the school education, name of university attended and course pursued, degrees received, references to professors or others, and a statement of subsequent practical experience, if any.

It does not seem to be the best policy to confine a technically educated apprentice to any particular department of the works for a period longer than is sufficient to fix well in his mind the methods involved in the construction of the mechanism there produced, and there is by no means a desire to keep him at a particular operation until he becomes a skilled mechanic. The aim is rather to familiarize him with the practical application of the elementary principles of the sciences, which he has already studied, so that he gradually becomes accustomed to think along mechanical lines. It is like learning a new language. No matter how much it may be studied, it cannot be

thoroughly acquired for practical service until daily association with others who are speaking it so accustoms him to its use that he finds he can think in it.

So in this advanced course, the apprentice, besides devoting somewhat over one-half his time to the shops, is placed in the engineering, construction, testing, and correspondence departments. In fact, his opportunities to become thoroughly familiar with the latest engineering practice are of the very best, and he is assisted and encouraged at all times to select the branch of work he desires to pursue.

TESTING AN ALTERNATING-CURRENT GENERATOR.

Constant vigilance is being exercised to discover those who show exceptional appreciation of the work, and it is easily possible for a young man to prove his worth and receive compensation proportionate to his value to the company, after he has served only a small fraction of his apprenticeship term. This opportunity acts both as an incentive and reward to the hard worker, for he feels that the time of preparation for his life work can be shortened materially by constant application and attention to duty.

Fairness in handling such a body of young men is a first consideration with the company. A properly scheduled course in the shops, with this object in mind, has been the means of bringing about most excellent results to all concerned. Each apprentice feels that he is

placed on an equal footing with the others; rivalry urges each to make the most of his time in a department.

The time and work are divided in a manner dependent upon their relative value to the apprentice. As little as one week is spent in some departments, while in others six months are considered desirable. Best practice indicates that experience in the department where apparatus is finally tested before shipment should come near the end of the course, as a thorough understanding of the apparatus as a whole should be obtained before the apprentice is allowed to operate it. In case of some defect, he is able to state its nature exactly, and in many cases a fault is discovered before a machine is put on test, thereby saving considerable time, and in many cases avoiding damage. The course strengthens confidence and develops perspicuity, which is lacking in those unfamiliar with the construction of the apparatus they are called upon to test.

THE ENGINEERING APPRENTICES. MR. DOWNTON STANDS IN THE RIGHT FOREGROUND.

Means have been adopted to study the capabilities of each apprentice and to encourage him in his work, both through personal observation of the foreman in charge of the apprentice department and by reports from the foremen in the shops. The latter are of two kinds: first, those in the nature of complaints regarding inaptitude for the work and for non-interest or mis-conduct, and are made at any time the foreman feels it is necessary; and second, those coming at the end of service in a department, being in the nature of a recommendation

on account of special qualification or for diligence. A set form for these reports is used, giving the foreman an opportunity to set forth the qualities of mind and character which he has observed in an apprentice and outlining the channel in which it is thought his energies should be directed in the future. The obligation to make these reports causes the foremen to take an observant interest in the apprentices, since his own qualifications as a judge of character and qualifications, and his ability to impart information to others, are at stake. His sense of responsibility for the future welfare of those in his charge is also developed, and a conscientious foreman will use every endeavor to study their characteristics and to lend encouragement to pursue the course, or the reverse, according to his intelligent conclusion as to their possible future development.

In order that the foreman in charge of the apprentice department may keep in touch with the work done by the apprentices, each is required to make a daily report, stating the nature of the work of each operation performed, and the time spent in its accomplishment. This statement is confirmed by the foreman and forwarded to the apprenticeship department where it is systematically recorded.

From a careful study of these reports an intimate acquaintanceship with each apprentice is obtained, and in a comparatively short time much knowledge is gathered which becomes of use in selecting men for positions with the company, according to the work which they are most capable of performing.

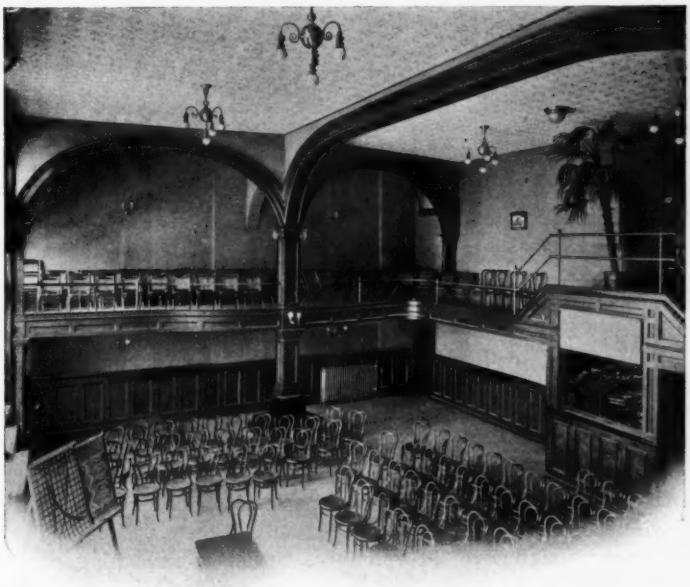
An effort is also made to inspire the apprentices with a common interest in their work. This leads to an open and free interchange of ideas and develops a quality of frankness which affects their whole career. It is made apparent that it is inadvisable for an employee to be reticent in order to retain his standing with the company. A general feeling of co-operation has resulted, which a year or so ago crystalized in the formation of an organization called The Electric Club.

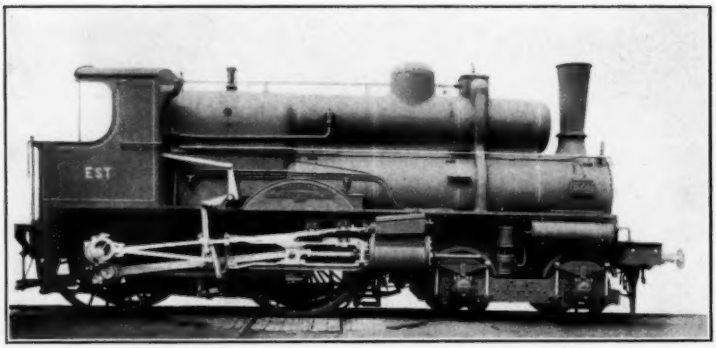
The Electric Club is an organization entirely separate and distinct from the company itself, although its membership includes nearly all the apprentices, engineers, and every member of the management of the Westinghouse Electric & Manufacturing Company. Its object is to foster physical, mental, and social recreation, but the educational features are most prominent.

Apprentices are encouraged to organize small clubs for the discussion of the details of electrical apparatus, and as a means for obtaining answers to questions upon difficulties that arise during working hours. The engineers of the company attend these sections to lend

encouragement and reply to questions. Lectures, both technical and general, are delivered on two evenings of each week, except during the summer months, by the engineers connected with the company, and in some cases by prominent practitioners in other lines who are invited to address the club. The local section of the American Institute of Electrical Engineers meets in the club rooms once each month, and in return for the privilege, members of the club are invited to be present and to participate in the discussions. A well equipped reading room has been provided, well adapted to the purpose. All the leading technical journals and current magazines, are accessible at all times.

The assembly hall, shown below, has a seating capacity of 250 persons, and besides this, there are seven other rooms used principally for class and section meetings. Social gatherings, encouraged by the wives of the engineers and officials of the company, are frequent and most enjoyable. The young men become associated in this manner with the very best people of the community. Such gatherings are thoroughly informal and attract the young men, who in many cases are of limited means and obtain but few opportunities for enjoyments possessing influences of an elevating and refining nature.





LOCOMOTIVE WITH DOUBLE BOILER, EASTERN RAILWAY OF FRANCE.

SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIREBOXES.

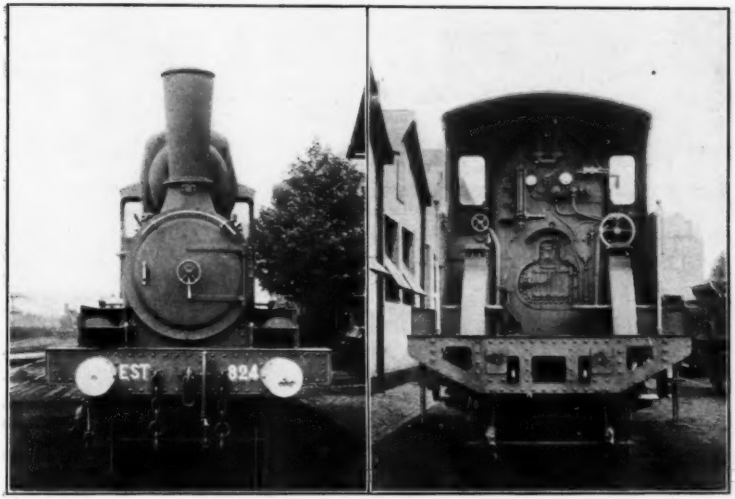
By Chas. S. Lake.

Mr. Lake's preceding papers have dealt with British locomotive practice in its most recent developments. It is of course impossible, within magazine limitations, to do more than touch upon the typical and leading features. The subjects and examples chosen are those which, in Mr. Lake's expert judgment, afford the greatest promise of advance in locomotive engineering practice. In this number he concludes his study by a rapid review of the most important recent work in the United States and on the Continent.—THE EDITORS.

IN 1891 the locomotive superintendent of the Eastern Railway of France, acting in conjunction with M. Flaman, the consulting engineer to that company, carried out some experiments with a boiler of novel construction, invented by the latter gentleman. In order that the idea might be fully tested before laying out a large sum of money on new construction, an old "Crampton" engine already working upon the line was taken into the shops and converted from its original state to that of being provided with the double boiler. The result of this was to elevate what had been previously considered as a machine suitable for dealing with traffic of minor importance only, to that of an engine capable of performing some of the heaviest work upon the system.

So successful were the results of this metamorphosing process that it was decided to construct some new and powerful locomotives

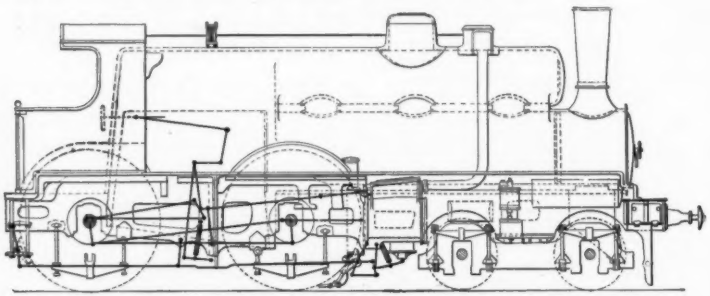
to have the Flaman boiler and firebox, and increased dimensions throughout. The outcome of this decision was that in 1892 a number of two-cylinder engines known as the "800" class were built at the company's works at Epernay, from the joint designs of M. M. Flaman and Salamon, the latter being (both then and now) chief engineer of the traction department of the line.



FRONT AND REAR VIEW, EASTERN OF FRANCE LOCOMOTIVE WITH DOUBLE BOILER.

Since the date of the introduction of the first of the series a large number of these engines have been constructed, and they are divided into two groups numbered 813 to 824 and 825 to 840. M. Salamon has kindly favoured the author with photographs, drawings, etc., of No. 824, one of the first to be built. By referring to these it will be seen that the boiler is composed of two barrels, one superposed upon the other. The lower or main barrel is filled with tubes, whilst the upper barrel or steam drum is devoid of them altogether. The two are connected by means of three connecting saddle pieces at intervals along their length. These are visible only when the engine is not in a complete state, as lagging plates are provided which encase the two chambers and thus hide the saddle pieces from view. The water level is, under normal conditions, just below the centre line of the upper barrel, which is connected at the rear end with the outer firebox casing.

The material employed in the manufacture of the boiler is open-hearth steel. The greatest possible care was taken in its construction, the whole of the plates being carefully reheated and annealed after the operation of flanging had been completed.



EXPRESS LOCOMOTIVE WITH DOUBLE BOILER, EASTERN RAILWAY OF FRANCE.

The boiler has a steam pressure of 170 pounds per square inch, and its total heating surface is 1,770 square feet. The great number of tubes is mainly responsible for this large aggregate. The total capacity of the boiler is 280.45 cubic feet, of which 63.25 feet are steam space.

The front plate of the firebox is of wrought iron as are also the steam orifice saddles between the two barrels. The firebox itself is of copper, but the roof is of steel and is corrugated, to reduce the amount of staying required. A water bridge of the Ten Brinck type is fitted inside the furnace, having a heating-surface area of 29.2 square feet. The total heating surface of 1940.8 square feet is made up as follows.

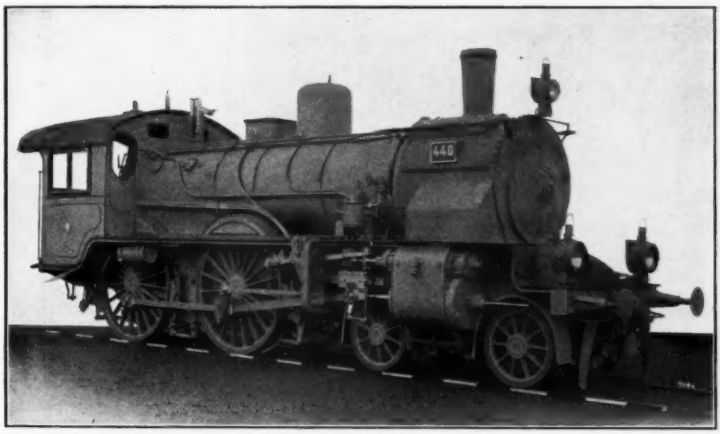
	Sq. feet
Tubes, (steel, 323 in number 1.57 exterior diameter and 14¼ in. in length)	1770
Firebox	146.6
Water bridge	24.2
Total	1940.8

It is claimed that a boiler of this description, deriving, as it does, all its heat in a direct manner from the firebox and the tubes, will utilise a greater proportion of the heat than will the ordinary type of locomotive boiler.

There are a number of locomotives in use upon the Prussian State Railways, both passenger and goods, which are fitted with a very

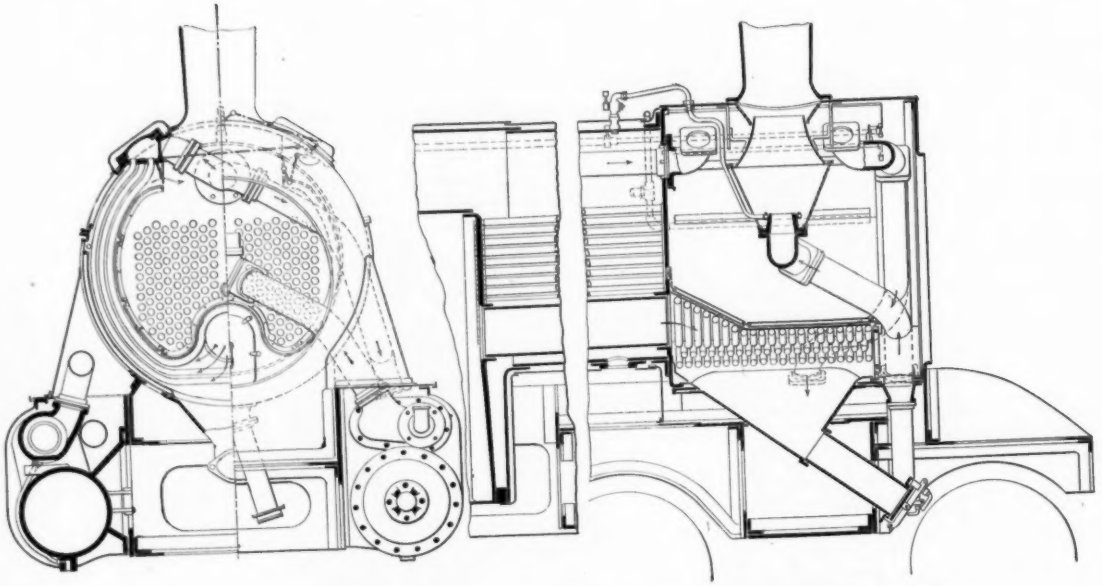
efficient form of superheating apparatus, the invention of Herr Wilhelm Schmidt of Wilhemshöhe near Cassel. These engines were built at the Borsig Locomotive Works, Berlin. The first of the series was exhibited at the Paris Exhibition of 1900, and since then many others have been put into service fitted with the superheater in an improved form. The figure illustrates one of these later engines, No. 440, an express passenger locomotive of an extremely powerful type. The sectional drawings show the general arrangement of the boiler, firebox, and smokebox, in the last-named of which the superheater is situated. This may be briefly described as follows:—

Extending from the firebox to the smokebox, and forming direct communication between the two, a large firetube, usually from 11 to 12 inches in diameter, is fixed. By means of this, the hot gases are conveyed from the furnace to an open space in the smokebox known as the superheating firebox.



BORSIG LOCOMOTIVE WITH SUPERHEATER.

The superheater itself consists of 62 tubes, ranging in size from 1 3/16 to 1 5/16 inches inside diameter, and from 1 1/2 to 1 5/8 inches outside diameter. These tubes are placed about the smokebox in three concentric rings, arranged in groups one behind the other. At their upper extremities they are expanded into a long steam chamber having branches out to right and left. The 21 tubes forming the inner group are arched up at the bottom and pass over the top of the 12-inch flue, clear of the two outer groups, which lie flat along the bottom of the smokebox as will be seen in the cross-sectional



SECTIONAL VIEWS OF SCHMIDT SUPERHEATER, APPLIED TO LOCOMOTIVE BUILT BY BORSIG, OF TEGEL.

views on the facing page. In this manner the open space or superheating firebox, already referred to, is formed, and the gases from the furnace are delivered into it by means of the large firetube.

Nearly the whole of the superheater is enclosed in an iron case on either side of the smokebox which can be opened or closed at will by the driver. The distributing steam chamber is at the right-hand side of the smokebox and has a partition in the centre. When the regulator is opened, the damp steam from the dome enters the back division and flows out through the rear to 10 of the three-fold groups of tubes and passes over to the left-hand steam chamber, arriving there in a fairly dry condition as a result of the operations so far carried out.

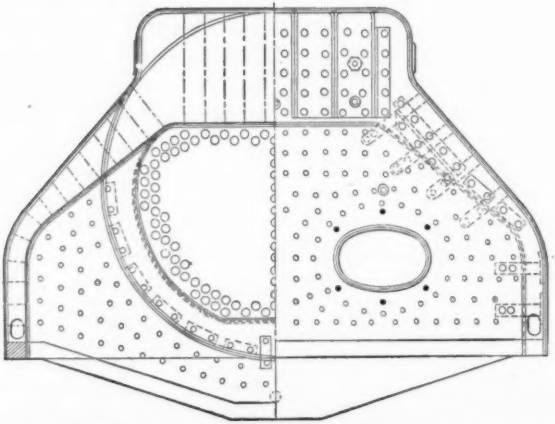
In this steam box there is no partition, so that the partially superheated steam enters the forward tubes of the three groups and flows back to the right-hand steam box and thence out to the cylinder steam chest. The soot which collects upon the tubes of the superheater can be removed by opening a blower valve, which permits of steam from the dome being discharged through two small apertures against the smokebox wall, at the back of the inner tubes. These jets of steam are directed upwards and downwards and pass between the superheating tubes. A wide-mouth ash pipe is provided for ridding the smokebox of soot and ashes which collect under the superheater tubes, and a second one for the boiler tubes. Herr Borsig states that with the improved pattern of superheater he is able to raise the temperature of the steam, which has a pressure of 170 pounds per square inch, to 575° F. as an average, and 626° F. at a maximum, whilst the coal consumption is reduced by 25 per cent. and water consumption 33 per cent. As the superheater is quite close to the cylinders, the result is that initial condensation is wholly abolished and the entering steam still superheated, so that the usefulness of the appliance is demonstrated beyond any question of doubt.

The total heating surface of the engine illustrated on pages 393 and 394 is 1,452 square feet, of which the superheater is responsible for 322 square feet.

Another example of special construction is to be found in the shape of a stayless boiler, with which some of the Prussian Street Railways locomotives—working in the Cologne district—are fitted. The shell consists of two truncated cones with a cylindrical portion on the middle and an inside corrugated firebox, so arranged that the ends of the boiler are of smaller diameter than the middle section. The top of the boiler is tapered in both directions, the longest slope being

towards the smokebox and the greatest steam space being approximately in the middle of the length of the boiler.

The tubes are sufficient to stay the tube plates and no further stays are required. The firebox is divided into two very nearly equal parts by a firebridge of semicircular form. The gases from the fuel are mixed at the firebridge with hot air and are consumed in the combustion chamber beyond.



WOOTTEN FIREBOX WITH BELPAIRE STAYING, PENNSYLVANIA ATLANTIC TYPE EXPRESS LOCOMOTIVE.

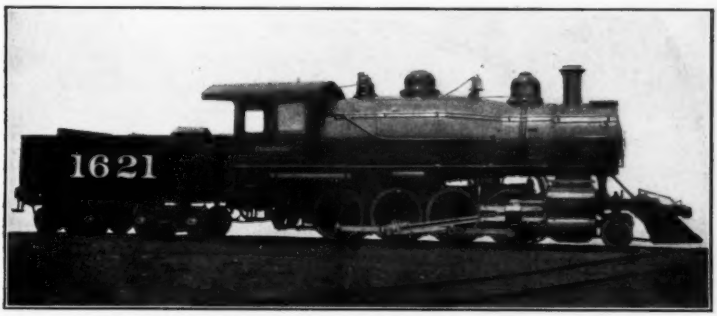
In the United States there are many and varied forms of locomotive boilers and fireboxes. The American loading gauge, which is of a far more liberal character than that which obtains on the European of the water, is mainly responsible for this. Boilers can be pitched with their axes at a much higher level above the rail there than is possible in any European country and, consequently, larger diameters are allowable and, as naturally follows, wider and deeper fireboxes can be used; therefore it is hardly to be wondered at that in this respect American locomotive engineering is in advance of British practice.

A pattern of firebox known as the "Wootten," or wide type, is largely used in the United States, and is especially applicable to engines of the "Atlantic" type with both pairs of coupled wheels placed in front of the firebox.

Just above is a cross-sectional view of the firebox of one of the Pennsylvania Railroad Company's Atlantic type express engines. This is a Wootten firebox with Belpaire direct staying, and a combustion

chamber—which is separated from the inner firebox by a brick bridge-wall—is provided. There are two firedoors, as indeed would seem to be necessary, seeing that the firebox is 8 feet long by 8 feet 6 inches wide, the grate area being no less than 68 square feet. This firebox is adapted for burning anthracite coal of which large quantities are available in the States. The driver's cab in these engines is placed ahead of the firebox over the top of the boiler barrel.

The Vanderbilt boiler is attracting much attention in America. This is another corrugated-firebox arrangement, and is very similar in general design to that upon the Lancashire and Yorkshire Railway already referred to. The cut below shows one of the "consolidation" compound engines built by Messrs. Burnham Williams & Co. of the Baldwin Locomotive Works, Philadelphia, for the Union Pacific R. R. The boiler of this engine is more in accordance with the original design than in some other "Vanderbilt" locomotives. The increased length allowable in the boilers of ten-wheeled engines permits of a first ring of small diameter being used, instead of this ring being tapered down to meet the diameter of the smoke box.



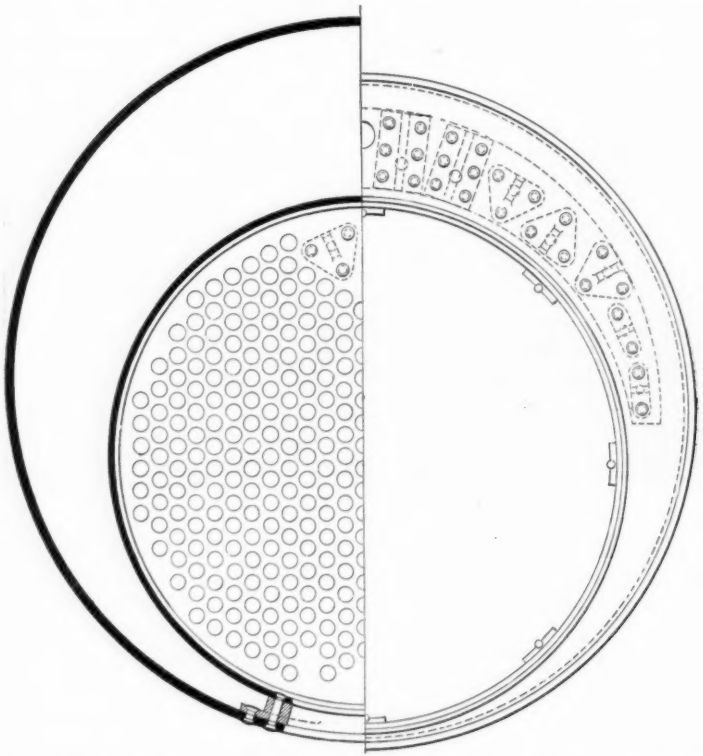
UNION PACIFIC LOCOMOTIVE WITH VANDERBILT CORRUGATED FIREBOX.

The first Vanderbilt boiler was constructed in 1899, an engine on the New York Central & Hudson River Railroad being fitted with it as an experimental measure. Doubts were freely expressed at the time as to the advisability of introducing corrugated fireboxes into locomotive construction, but in course of time it became evident that no substantial difficulties were incurred by the practice, and the result of this is seen at the present time in the more general adoption of the device.

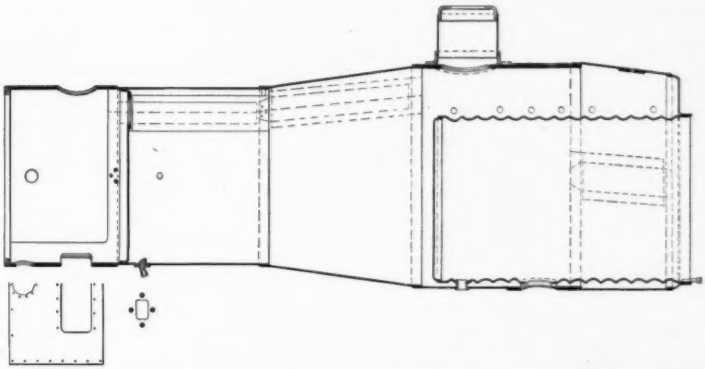
As has been already remarked, there are many expedients and devices in common use in the United States which are absoluetly pre-

cluded from adoption in Great Britain owing to the restrictive character of the limits allowed by the loading gauge and similar considerations. There is a noticeable tendency, however, in Europe, to take advantage of those special characteristics which come within the permissible scope of operations. The Belpaire firebox is becoming quite a common feature of British practice, and is largely used upon the Continent. The advantages claimed are those of direct staying, (both the crown of the firebox and the top of the outer shell having flat surfaces specially adapted for this purpose) and, further, a free circulating area for the water. Longitudinal roof stays are not needed in this pattern of firebox as in those of the ordinary description.

The majority of engineers now provide locomotive boilers with



SECTIONAL VIEW OF BALDWIN LOCOMOTIVE BOILER WITH VANDERBILT CORRUGATED FIREBOX.



LONGITUDINAL SECTION, BALDWIN LOCOMOTIVE BOILER WITH VANDERBILT CORRUGATED FIREBOX.

steam domes—in fact, the practice may be said to be almost universal. Dry steam is a great consideration, and although the provision of a dome does not secure this in anything like a full measure, it goes a long way towards the attainment of the desired object and prevents a great deal of priming. Where boilers are designed to carry very high pressures, such as 200 pounds or more, per square inch, it seems to be advisable to provide four safety valves. A few British engineers are now doing this, as well as those in other countries.

"Serve" tubes, with internal longitudinal ribs, are very prevalent in France and other parts of the Continent. Mr. S. W. Johnson has fitted one of his new compound locomotives with them on the Midland Railway. The net gain in added effective heating surface is said to be considerable. The *nominal* gain is certainly very imposing. In this, as in the majority of other special appliances, a great deal, of course, depends upon circumstances.

In conclusion I desire to tender my thanks to the various locomotive superintendents and others, whose cordial assistance, in the provision of providing photographs, drawings, and particulars, has been of the utmost service in the preparation of this article.

THE COAL-MINING INDUSTRY OF THE UNITED KINGDOM.

By R. A. S. Redmayne.

III. THE PRESENT AND THE FUTURE OF BRITISH COAL MINING.

Professor Redmayne's first article, which appeared in our October number, was a historical review of the early period when Great Britain's supremacy in coal mining was undisputed. The second dealt with the era of the increasing use of power-driven machinery, which also was the epoch of the rise of external competition. The concluding article now published treats the subject in its present economic aspects, with particular reference to the very important matter of labour conditions and the future of the industry.—THE EDITORS.

THE question is sometimes asked by the uniniated, "What is there to learn about coal mining?" It seems to the questioner all that is necessary is to make a hole in the ground and proceed to dig out coal! In reality the science and art of coal mining is one of the fullest applications of all the sciences, and a well equipped modern colliery "presents one of the most remarkable exhibitions of human activity and its triumph over matter." It is a marvel of applied mechanical science, with its great shafts upwards to 20 feet in diameter, its systems of mechanical haulage above and below ground, ventilating fans drawing vast volumes of air often amounting to hundreds of thousands of cubic feet per minute through miles of confined passage, the timbering, mechanical coal cutting, the lighting, and its great winding and pumping engines. To adequately superintend such a colliery, employing, perhaps, 3,000 men and raising a million tons per annum, the mine manager must have considerable knowledge; he must be well grounded in pure science, especially in geology, chemistry, and mechanics, and have had much experience in civil and mechanical, as well as mining, engineering. He must be somewhat of an architect and a good draughtsman, and must be possessed of tact and discrimination—most necessary qualities in one who has to deal with large bodies of men.

Nothing, perhaps, more conclusively demonstrates the great advances that have been made in the management of British collierics and the condition of the employees than what has been done towards the prevention of accidents in the mines during recent years, and the increase in rate of the wages received by the workers.

Taking figures calculated over all the coal mines in the Kingdom, there were in

the	year	1851	for	each	fatal	accident	219	persons	employed.
"	"	1861	"	"	"	"	300	"	"
"	"	1871	"	"	"	"	345	"	"
"	"	1881	"	"	"	"	519	"	"
"	"	1891	"	"	"	"	665	"	"
"	"	1901	"	"	"	"	733	"	"
"	"	1902	"	"	"	"	805	"	"

On putting it in another way, and taking the year 1900, there was—

for railways, one person killed for every 1,052 employees.
for coal miners, one person killed for every 744 employees.
for seamen in merchant vessels, one person killed for every 133.

At the beginning of the nineteenth century coal miners (coal hewers) received from 2s 3d to 2s 6d per shift of eight to twelve hours; they now receive about 6s for a seven and a half hour shift: that is to say, the coal hewer's wage has, without allowing for increased purchasing power of money, nearly trebled during the last century. Taking underground labour generally, wages are now on an average at least 50 per cent. higher than they were seventy years ago, and the hours worked are quite 20 per cent. less.

It is difficult to make any general statement as to interest on invested capital, but the earnings of the colliery owner have not increased in the same ratio as the rate of wages received by the working miner. Mr. T. H. Elliott, from evidence given before the Royal Commission on Mining Royalties, drew up a report in compliance with the instructions of the President of the Board of Trade, in which he distributed the whole product of the coal trade for the year 1889 thus:—

Wages	55	per cent.
Royalties	8	"
Other charges	25	"
Profit	12	"

According to Mr. J. B. Simpson, a prominent mining engineer and colliery owner in the north of England, the only approximate guidance of much worth in determining the value of the collieries of the kingdom which we can obtain, is from the Inland Revenue returns; but these include the mines of copper, lead and zinc as well. The assessment also includes the rent and royalty. He, however, endeavoured to arrive at an estimate by taking the results given in these returns for thirty years and making a deduction for rents included as estimated by the Royal Commission on Royalties for 1889. The result was 6d per ton profit on all minerals mentioned, but as the greatest proportion of mines were collieries, the figure seems a fair one to take as the average profit on

coal for thirty years. If as Mr. Buddle estimated, in the year 1829 it required 8d per ton, to give a 5 per cent. return to the capitalist, the result would be a poor one indeed! In the Report of the Labour Commission of 1893, it was stated that a capital of £100,000,000 was embarked in coal mining in the United Kingdom. 6d per ton profit on an output of 200,000,000 tons of coal gives a return of £5,000,000 per annum. That is to say, sufficient only to give 5 per cent. on the capital invested, and this for all the risks and responsibilities, many of which do not occur in other industries, and from this should be set aside at least 1½ to 2 per cent. to provide a redemption fund to meet the loss of capital which ensues at the end of the lease.

An interesting return was issued in June of this year by the Board of Trade in the form of a Parliamentary paper, "Showing for the United Kingdom and the principal coal-mining districts the quantity and value of coal produced and the number and average wages of coal miners in the years 1901 and 1902 respectively, together with the estimated amounts expended on miners' wages, and remaining for other expenses and coal owners' profits in the United Kingdom for each year."

The manner of arriving at the miners' wages in this return is not accurate; though the amount of error is probably only small, it is still sufficient to influence greatly the amount of profit. In an interesting article in the *Colliery Guardian* for June 19 on the subject of "Coal Owners' Profits," figures are taken out of this Parliamentary Report to show the gross profits earned by capital after payment of all risks:—

	1902.		Average, 1892-1901	
Wages	61,053,000	5s. 4.5d.	49,382,000	4s. 11.5d.
Other expenses	18,924,000	1s. 8d.	16,565,000	1s. 8d.
Profits	13,542,000	1s. 2.3d.	7,105,000	0s. 8.7d.
Total	93,519,000	8s. 2.8d.	73,052,000	7s. 4.2d.

And taking £125,000,000* as the amount of capital invested in coal mining in the United Kingdom, there is given a profit over the last ten years of £5. 13. 8. per cent. One hears of the huge profits occasionally made in the coal trade, but little mention is made of the fortunes that have been lost in coal mining. The fact is, that the risks attendant on coal, as in all other mining ventures, are great, and given even a good and well developed colliery, the trade itself is one of the most variable. Taking the Tyneside district this is diagramatically shown over a series of years in Figure 1. Much depends on when a capitalist enters the coal trade and when he leaves it, whether he realises or loses a fortune.

* Which is probably nearer the mark than £100,000,000.

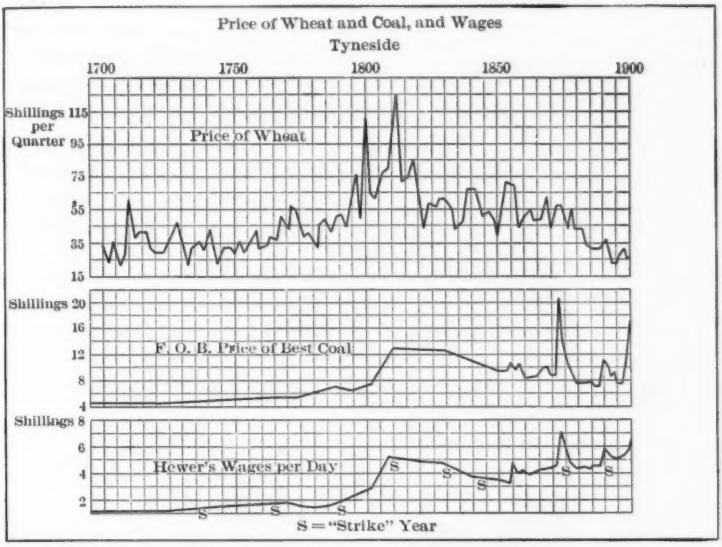


FIG. I. SHOWING VARIATIONS IN THE PRICE OF WHEAT AND COAL, AND RATE OF COAL-HEWER'S WAGES, IN THE NORTH OF ENGLAND (TYNESIDE) BETWEEN THE YEARS 1700 AND 1900.

In considering the present position of the coal-mining industry in Great Britain, two main facts present themselves to the attention of the thoughtful—the approaching exhaustion of the shallower portions of the exposed coalfields, and the growing competition of foreign coal producers.

Professor Hull, at the end of the last century, calculated the area and tonnage yet remaining to work in the visible and concealed coal fields within a depth of 4,000 feet, and excluding seams less than 2 feet in thickness, to be:—

In visible and partly concealed coalfields	58,275,700,000	tons.
In entirely concealed areas	23,253,000,000	"
In Irish coal fields (visible and concealed).....	155,300,000	"
Total for United Kingdom	81,684,000,000	

or sufficient coal to last, at the present rate of output of, say, 220 million tons per annum, for a period of 371 years.* But some of the exposed coal fields will be exhausted long before this date is reached.

* Professor Hull puts this period at a little over four hundred years, but he takes as his divisor 200 million tons only.

The question as to whether the present rate of output will be maintained can only be a matter for conjecture, as it is governed by three factors—the home consumption, foreign demand, and the state of the freight market, and these again are controlled by further and diverse circumstances. The probability is that the output will be increased, though not at the same ratio as heretofore. The increased and daily increasing economy in the consumption of fuel by reason of the fuller utilisation of its absolute heat value, brought about in great measure by the high price of fuel, will assist in preventing this. The output for the

FIG. 2. COALFIELDS AND SHIPPING OUTLETS OF THE UNITED STATES.

year 1900 was approximately 225 million tons, for 1901, 219 million tons, and for 1902, 227 million tons, the last figure being the highest in the history of the coal trade of the United Kingdom.

The United States of America is Great Britain's most important competitor in point of output, as will be seen from an inspection of the

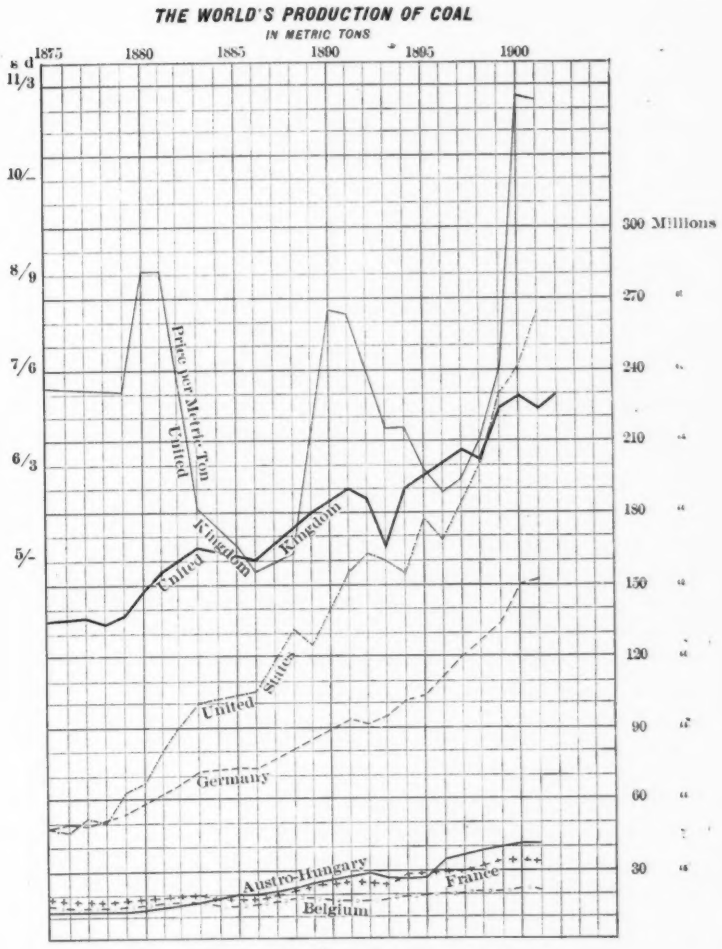


FIG. 4. WORLD'S PRODUCTION OF COAL.

diagrams Figures 3 and 4. Up to 1899 Britain was the largest producer of coal of any country in the world, but in that year the United States took this position from her, with an output of 226,554,000 tons as against 220,094,781 tons, the production of Great Britain. Taking the figures for the commencement of the new century, the world's output was 767,636,204 tons divisible as follows (see Figure 4) :—

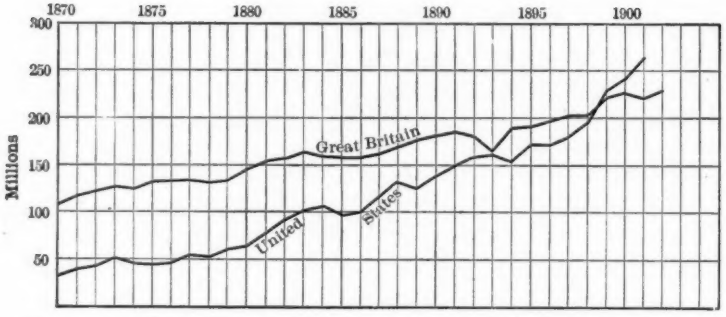


FIG. 3. DIAGRAM SHOWING PRODUCE OF COAL (LONG TONS) IN GREAT BRITAIN AND THE UNITED STATES.

		Millions of tons.		Per cent.	
British Empire	United Kingdom	229	=	30	32.4
	British possessions	19	=	2.4	
United States of America		245	=		31.9
Rest of the world		274.5	=		35.7
					100.00

It is a noticeable fact that of late years the increased production of coal by the United States has been concurrent with an increasing use of mechanical coal-cutting machinery. Referring back to the time when this kind of machinery was coming into something like general use, about the year 1891, the output in America was 156 million tons, the output for Great Britain being 189 million tons. Comparing these figures with those for 1900, America shows an increase of 89 million tons, against 30 million tons for Great Britain. In the year 1891 there were about fifty firms using in all 550 coal cutters in the United States. In 1900 there were 320 firms using in all 3,900 machines, the coal cut per machine being approximately 10,150 tons in 1891 and 12,050 tons in 1900. But in Great Britain the results shown are very different, there being only 290 machines in use in 1900.*

Nearly 20 per cent. of the total output of America, in fact, is cut by machine; and there are employed in the coal mines some 450,000 as against 760,000 persons in Great Britain.† See Figures 5 and 6.

Germany, also, whose output of coal has doubled within the last ten years, reaching 150 million tons in 1900, is a strenuous competitor.

* Since the above was written the figures for 1902 are available. There were in that year 166 collieries in the United Kingdom using in all 483 machines which cut 4,161,202 tons of coal, or about 1¾ per cent. of the total output of coal for the year.

† The number of persons employed in British coal mines in 1902 was considerably in excess of the figures given here, viz., 824,791.

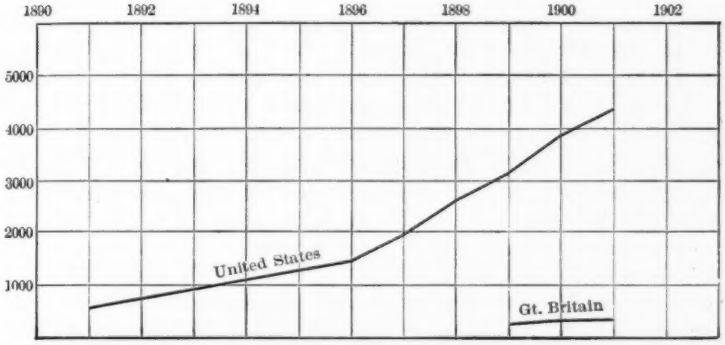


FIG. 5. DIAGRAM SHOWING THE RELATIVE NUMBER OF COAL CUTTERS IN USE IN GREAT BRITAIN AND THE UNITED STATES.

Whereas there is in America a vast quantity of coal near to the surface, which can therefore for many years be cheaply mined, the shallower deposits in Britain are rapidly approaching exhaustion, and the question of deep mining is one of imminent importance.

At the time of the Argyll Commission it was assumed that coal could not be worked, except at a prohibitive cost, at a greater depth than 4,000 feet, owing to the heightened temperature and increased pressure due to depths beyond this limit, and we have seen that the quantity of coal remaining to work at the end of last century within this limit was sufficient to last at present rate of consumption for under 400 years. Yet there are seams of coal lying at much greater depth

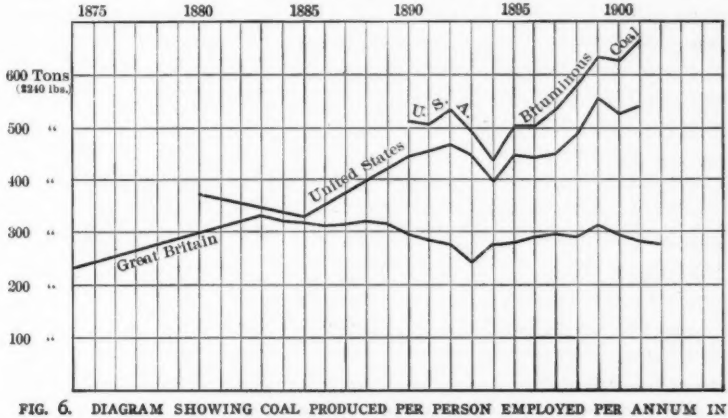


FIG. 6. DIAGRAM SHOWING COAL PRODUCED PER PERSON EMPLOYED PER ANNUM IN GREAT BRITAIN AND THE UNITED STATES.

than this limit in Cheshire, North Staffordshire, Yorkshire, and South Wales, the contents of which should certainly be included in any estimate of the nation's coal supply, at any rate to a limit of 6,000 feet.

Taking the three contentions urged against the feasibility of working coal at great depths in the order here stated, (1) the economic consideration (2) unendurable temperature, and (3) excessive pressure, let us see whether these are likely to act as deterrants to mining down to a 6,000 feet limit.

1.—Economic Considerations. The mechanical difficulties of deep sinkings are not now anything like so great as they were, say fifty years ago, before the era of machine drills of great efficiency, high explosives, and powerful winding machinery. Therefore a modern deep sinking, by reason of improved methods, would be neither so costly nor so slow of accomplishment as a like sinking of fifty years ago.

2.—Increase of temperature. In the report of the last Coal Commission previously alluded to, the conclusion is arrived at that at a depth of 3,000 feet, the temperature of the earth would amount to 98° F, but it was thought that a depth of at least 4,000 feet might ultimately be reached in coal mining. (Report Vol. 1, p. 88) The rate of increase the commissioners thought might, for ordinary cases, be assumed to be 1° Fahr. for every 60 feet; but it is in reality impossible to give any fixed rate of increase. The Report of the British Association Committee on Underground Temperatures, during the last thirty years, tends to show, not only that the temperature gradient varies considerably in different localities, but that it is not easy to deduce a fixed law of increase applicable to all cases. In some parts of western America the heat at 3,000 feet is almost unbearable, while at the Calumet and Hecla Copper Mine in northern Michigan, U. S. A., there is a rise of only 4° Fahr. in a depth of 4,400 feet, although no artificial ventilation is resorted to. The temperature of the coal on discovery at the Rosebridge Colliery in Lancashire, was stated by the management to be 93° Fahr., but it afterwards fell to 63° Fahr.

3.—It does not appear that the question of pressure need be regarded as a bar to working our deeper coal seams, seeing that, certainly up to 7,000 feet—beyond which limit it is doubtful if there be much coal in the British Isles—it would not act as a preventive.

To sum up the situation. It appears that there is coal in the United Kingdom to a depth of 4,000 feet, sufficient at about the present rate of output to suffice for 371 years, but that this period will be considerably extended seeing that there is every probability that mining can be carried on to a depth of 7,000 feet, though at this depth there will not

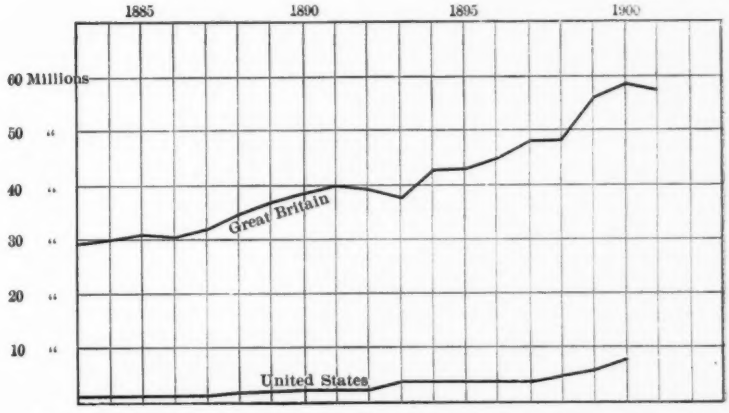


FIG. 7. QUANTITY OF COAL EXPORTED FROM GREAT BRITAIN AND THE UNITED STATES.

be anything like the area of coal that there is at the former limit. And it further seems reasonable to expect that this period of supply may be still further extended by the more economical use of fuel, due to the establishment of central electrical supply stations, and the utilisation of Mond and other gas-producing processes, and of gas-driven engines, as well as other means of obtaining a higher percentage of the heat value of the fuel. Professor Jevons maintains "it is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth," but in this he is not quite correct. To take but one instance. In all well managed collieries there is a constant effort to keep down the percentage of coal that goes to "colliery consumption." Any saving effected does not go towards further development, but to profit. Speaking generally, economy does lead to increased consumption, but not to the extent of the economy effected.

Turning to foreign competition; this must necessarily for some time be an increasing factor, owing to the great developments that have been made and are taking place in the coal-mining districts on the Continent and in America. In order to compete successfully with our rivals for the trade, we must fight them with their own weapons; some of them can be enumerated:—The more perfect screening and cleaning of our coal, the introduction of labour-saving appliances to the greatest possible extent, such as coal-cutting machinery—in fact the elimination, as far as is possible, of the human factor in mining and preparing the coal for the market, and the higher training of our mining engineers.

THE SYSTEMATIZED OPERATION OF ISOLATED PLANTS.

By Percival Robert Moses.

Mr. Moses' opening words well indicate the interest of his theme. With the extension of the use of electricity and the increase in the size of individual buildings, the isolated plant is following the course of all modern business and reaching the stage where system and organization must take the place of individual management—or at least, of the hand and eye of the individual manager. And it is hardly necessary to point out that the electric plant of the modern large alartment quite equals, in both size and diversity of duty, many a public central station which but a few years ago would have been thought of very fair size. The methods advanced by Mr. Moses, therefore, have even a more general application than the title suggests.—THE EDITORS.

THE systematic operation of steam and electric plants for private purposes is becoming of greater importance as the size and number of these plants increases. Formerly when buildings were five-stories high and scattered over large areas, isolated private power plants were few and of small size. Under present conditions, with buildings covering an acre or more of ground and rising twenty or thirty stories in the air, the problem has become different and vastly more important. It is no longer sufficient, nor is it safe, for an owner of a large building to let things run themselves, contenting himself with looking at the bills at the end of the month. With a competent operating engineer he can do it, but it will be expensive in nine cases out of ten; and with an incompetent man frightful accidents are possible and the plant is sure to run down.

A power plant of a modern high building may contain boilers, engines, dynamos, switchboard, pumps, refrigerating and ice-making machinery, elevators, steam-heating, electric-lighting, and plumbing appliances, and other apparatus. All this must be taken care of and watched. Systematizing the operation covers the employment and regulation of the engineer and his staff; the recording and tabulation of the work done by the plant, of the conditions under which this work is done, and of the material and labor required to produce it; the purchase of supplies and the comparison of their values, and periodical inspection.

Small plants with a single boiler and engine, as well as large plants containing thousands of horse power of machinery, are the better for

such a system. With the small plant the economy is often greater proportionately than with the large one, as in the larger plant a higher class of intelligence is obtainable. In all cases the amount of red tape and records should be reduced as low as consistent with a complete knowledge of the operation cost, as too much information may result in no attention being paid to the records.

In the employment of engineers and their assistants, application blanks are great time savers and a convenient means of filing applications. This blank is to be filled out by the applicant in his own handwriting, and not only are the age, nationality, and references, etc., shown, but the neatness, education, and sometimes sobriety of the applicant may be judged. The references given on the blank should be looked up, the people seen if possible, and the results endorsed on the application. Written references are of little value, as the most useless engineers often have first-class letters and license. When the choice is made, some form of written agreement should be signed, covering the hours, amount of pay, duties, overtime work, reasons for summary discharge, notice of intention to leave, and termination of pay in event of summary discharge for cause; with the chief engineer, further details as to staff allowed, purchase of supplies, commissions, etc., may be added if desired; the object is to have a full and complete understanding before hand.

The duties of a chief engineer in a large plant are wholly executive; that is, he is the director, and his work should be confined to directing and overseeing the work of his subordinates; he should be held responsible for the fulfilment of rules, correctness of records, discipline of the force, and condition of the machinery. Hence the force under him should be subject to his orders only and be approved of by him. The chief engineer should have nothing whatever to do with the purchase of supplies, except to test and report on their value, to make out or approve requisitions, to check receipts, and to note quantity of material on hand. He should make a daily summary of the plant operation, and render a monthly and annual report as hereafter indicated. While the engineer should not as a rule do any adjustment or manual work around the plant, he should be a practical man able to do the work when necessary, and capable of teaching his men by personal example. If he studies and is technically educated, so much the better.

The chief engineer of a small plant, less than 500 horse power, must necessarily be a working engineer. His duties are similar to those of an assistant on a large plant—i. e., adjusting working parts, making

APARTMENT HOUSE

DAILY POWER LOG

DATE_____

TIME	AMPERES NO.1	NO.2 A	NO.2 B	NO.3 A	NO.3 B	NO.4	NO.5	TOTAL	VOLTS A	VOLTS B	STEAM HIGH	STEAM BACK	TEMPERATURES BRINE INLET	BRINE OUTLET	WATER INLET	WATER OUTLET	ICE TANK	FEED WATER	REF. PLANT PRESSURES GEN.	ABS.	BRINE	WATER	ST'M GEN.		NOTES AND REMARKS
7A.M.																									
8A.M.																									
9A.M.																									
10AM.																									
11AM.																									
12N.																									
1P.M.																									
2P.M.																									
3P.M.																									
4P.M.																									
5P.M.																									
6P.M.																									
7P.M.																									
8P.M.																									
9P.M.																									
10PM.																									
11PM.																									
12M.																									
1A.M.																									
2A.M.																									
3A.M.																									
4A.M.																									
5A.M.																									
6A.M.																									
TOTAL																									

TIME SHEET

EMPLOYEES	ARR.	LV.	EMPLOYEES	ARR.	LV.	MACHINES	START	STOP	MACHINES	START	STOP	NOTES
CHIEF ENG.			COAL PASSER 1			BOILER 1			ICE MACH.			KIND OF DAY
1ST ASST."			" " 2			" 2			GEN.NO.1			CANS OF ASHES
2ND " "			" " 3			" 3			GEN.NO.2			QUALITY OF COAL
3RD " "			" " 4			" 4						QUANTITY OF COAL ON HAND
4TH " "									BRINE PUMP 1			TEMPERATURE 7 A.M.
			OILER NO.1			ENGINE 1			" " 2			
FIREMAN 1			" " 2			" 2						
" 2			" " 3			" 3			VOLT PUMP 1			
" 3						" 4			" " 2			
" 4						" 5						
" 5			ELECTRICIAN 1									
			" 2			ELEV.PUMP1						
1ST ICE MAC.						" " 2						
2ND ICE MAC.			PLUMBER NO.1									
MACHINIST			" " 2									
LABORER 1												
" 2			OTHERS									
" 3												

DAILY POWER LOG, OR WATCH REPORT, FOR APARTMENT HOUSE POWER PLANT.

Made out by engineer on duty. Original is 17 inches wide by 14 inches high. Perforated in the margin for binding.

repairs, taking records, directing firemen and oilers, with the added duty of the daily, monthly, and yearly summary. This work demands a man with more ability than an assistant on a large power plant, as he is more his own master and has to meet questions of greater variety.

The other members of the staff have special duties to perform, and their knowledge of these specialties is the measure of their value. Honesty, common sense, ambition, and sobriety are the real essentials; the other qualities and accomplishments can be developed.

Subdivision of the work to be done is important, as in this way only can time be employed advantageously, men used for the work for which they are best fitted, and most important of all, responsibility fixed for omissions or faults. There are certain duties to perform at stated intervals—e. g., elevator machinery must be inspected, oiled, and cared for daily; boilers must be blown down and their safety valves tried; engines must be indicated, gauges tested, etc. If it is not done there is someone to be held accountable. Of course, all this is subject to variation when contingencies arise; when they do, the man detailed must report his inability so that the work can be handled. It is a good plan to have each man thus detailed provided with a book in which the work done and the time required may be briefly noted. At the end of the day the books are turned in to the chief. The general operation of the plant is recorded by hourly reading of the wattmeters, ammeters, voltmeters, steam, ammonia, and water gauges, thermometers, and water meters.

These record sheets are the foundation of system in operation; they are greatly lessened in value unless filled out with care, and studied. Their value for cost determination has been treated in a previous paper* on "Cost Determination in Isolated Plants," but their bearing on the operation and on the employees deserves notice. A poor engineer —a lazy, uneducated, or unambitious man—will not bother with them; the other type—the ambitious, studious, and working engineer—will not only fill out the blanks as indicated, but take pains to get more information and to put it on record. Some of the blanks used in what is said to be the largest apartment house in the world are shown on pages 414-416. This building covers a plot 200 feet square, and rises seventeen stories above the curb, with two stories below. It contains 1,400 horse power of boilers, 1,600 horse power of compound high-speed engines directly connected to 1,000 kilowatts of dynamos, triple and compound elevator pumps, hot, cool, and iced-water systems, ven-

* Cost Determination in Isolated Plants; Percival Robert Moses, THE ENGINEERING MAGAZINE, March, 1901, p. 1082 *et seq.*

APARTMENT HOUSE

DAILY METER REPORT BLANK

DATE,_____

NAME OF METER	METER READING	DIFFERENCE IN READINGS	AMOUNT USED IN 24 HOURS	COST	COST PREVIOUS YEAR	NOTES AND REMARKS
WATER						
LAUNDRY	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HOUSE NO. 1	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HOUSE NO. 2	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HOUSE NO. 3	PRESENT 7 A.M. 7 P.M. PREVIOUS					
TOTAL						
BOILERS	PRESENT 7 A.M. 7 P.M. PREVIOUS					
REFRIG. MACH.	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY (HOT)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY (COLD)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
KITCHEN (HOT)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
KITCHEN (COLD)	PRESENT 7 A.M. 7 P.M. PREVIOUS					
TOTAL						
GAS						
DINING ROOM NO. 1	PRESENT 7 A.M. 7 P.M. PREVIOUS					
DINING ROOM NO. 2	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY NO. 1	PRESENT 7 A.M. 7 P.M. PREVIOUS					
LAUNDRY NO. 2	PRESENT 7 A.M. 7 P.M. PREVIOUS					
HALL	PRESENT 7 A.M. 7 P.M. PREVIOUS					
KITCHEN	PRESENT 7 A.M. 7 P.M. PREVIOUS					
TOTAL						
ELECTRICITY						
	PRESENT 7 A.M. 7 P.M. PREVIOUS					
	PRESENT 7 A.M. 7 P.M. PREVIOUS					
	PRESENT 7 A.M. 7 P.M. PREVIOUS					

DAILY METER REPORT BLANK FOR APARTMENT HOUSE PLANT.
17 inches high by 13 inches wide. Perforated at the top for binding.

tilating, heating, and refrigerating apparatus, and pumps of various kinds. Electricity is supplied for lighting and for motors driving laundry and ventilating appliances. Brine is pumped through coils in refrigerators, located in various apartments, cooling these, and allowing ice to be made in shallow pans by the tenants. About 5 tons of ice per day is made in the ice-making tank for restaurant and kitchen use.

An example of the interest intelligent engineers take in such records is shown in this plant, as the day and night engineer vie with each other as to who can turn out the most complete records, and the chief engineer spends hours of his spare time studying and tabulating the results. The first or basic blank is the watch report made by the engineer on duty, and shows the hourly condition of the plant, through record of amperes delivered by each dynamo; and in the case of 3-wire balance-coil dynamos, of each side of circuit, voltage on each side of system; high and low steam, ammonia, and brine pressures; brine, ice, and feed-water temperatures. The men on duty and the machines in operation are also noted, and any repairs done. The meter blanks filled out once or twice daily show the quantities of water, gas, and electricity consumed in different departments, and the daily summary

APARTMENT HOUSE

CHIEF ENGINEER'S SUMMARY OF DAILY OPERATION

DATE. _____

ITEMS	QUANTITY OR NUMBER	RATE	COST	COST YEAR PREVIOUS	REMARKS NOTE HERE ANY COMPLAINTS, ACCIDENTS, SUPPLIES RECEIVED, REPAIRS MADE, FULLY.
COAL	LBS.				
WATER	CU. FT.				
GAS	CU. FT.				
ASH REMOVAL	CANS				
CYLINDER OIL	GALS.				
ENGINE OIL	"				
	"				
	"				
WASTE	LBS				
PACKING	"				
	"				
	"				
	"				
LAMPS 8 C.P.					
LAMPS 16 C.P.					
LAMPS 25 C.P.					
LAMPS 32 C.P.					
LAMPS 50 C.P.					
SUNDRIES					
REPAIRS					
WAGES,					
BOILER PLANT					
ELEC. PLANT					
ICE PLANT					
TOTAL COST					

KILOWATT HOURS ELECTRICITY SUPPLIED
ICE MADE
WATER EVAPORATED PER POUND OF COAL
KIND OF FUEL
KIND OF DAY
TEMPERATURE 7 A.M.
TEMPERATURE FEED WATER
TEMPERATURE CROTON WATER

SIGNED

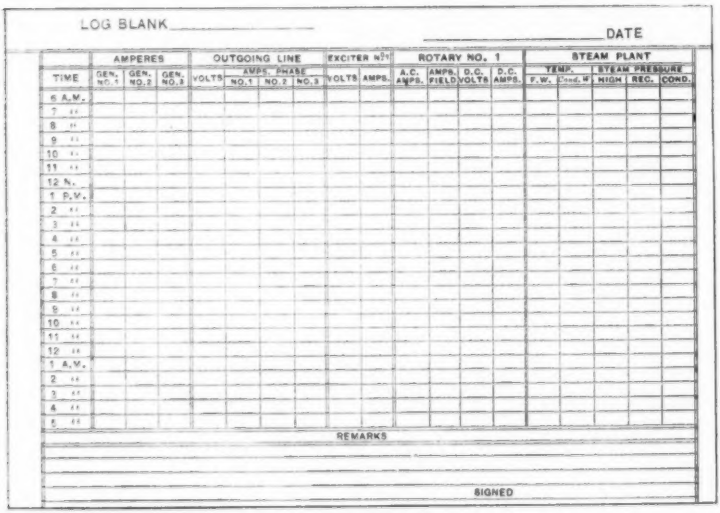
FORM FOR CHIEF ENGINEER'S SUMMARY, APARTMENT HOUSE POWER PLANT.

13½ inches wide by 17 inches high. Bound in books by perforated right hand margin. The original allows greater proportionate space at the bottom for notes or remarks.

shows the cost of each factor for the day, the cost for the same day of the previous year, the quantities of electricity and ice made.

Another set of record blanks is shown for a power plant supplying electricity to motors, etc., for irrigation and sugar manufacture. The main features are the same as those of the apartment-house blanks—that is, one blank contains the hourly records of electricity, steam, and temperatures, and the time sheet of men and machinery; the second blank shows total power supplied for irrigation, power for mill and light; also amount of coal, labor, oil, etc., required; the cost of each item and the total cost; supplies received and required, and such notes as the chief engineer wishes to record. Other blanks are used for repair, or new work, showing quantity and cost of labor and material used. The records are forwarded to the New York office, and curves made showing at a glance variation in cost per unit of power, etc. This plant has been in operation about a year, and the records are not only instructive as to design of future plants, but also point the way to economize in present operation.

The value of the hourly report lies not only in the data made available, but in the frequent inspection of the different pieces of apparatus



LOG BLANK_____ _____DATE

TIME	AMPERES			OUTGOING LINE				EXCITER No. 1		ROTARY NO. 1				STEAM PLANT				
	GEN. NO. 1	GEN. NO. 2	GEN. NO. 3	VOLTS	AMPS. PHASE NO. 1	NO. 2	NO. 3	VOLTS	AMPS.	A.C. AMPS.	AMPS. FIELD	D.C. VOLTS	D.C. AMPS.	TEMP. F.W.	TEMP. Cond. W.	STEAM PRESSURE HIGH	STEAM PRESSURE REC.	STEAM PRESSURE COND.
6 A.M.																		
7 "																		
8 "																		
9 "																		
10 "																		
11 "																		
12 N.																		
1 P.M.																		
2 "																		
3 "																		
4 "																		
5 "																		
6 "																		
7 "																		
8 "																		
9 "																		
10 "																		
11 "																		
12 "																		
1 A.M.																		
2 "																		
3 "																		
4 "																		
5 "																		

REMARKS

SIGNED

WATCH REPORT (OR LOG BLANK) OF A CENTRAL STATION SUPPLYING POWER FOR SUGAR MANUFACTURE AND IRRIGATION.

Filled out by the engineer on duty. Actual size 12¾ inches wide by 11¼ inches high. Extra columns are provided for additional rotaries and exciters.

SUMMARY SHEET No. _____

DATE _____

WATTMETERS		SUPPLIES USED				EMPLOYEES TIME					OPERATION OF MACHINES		
OUTGOING LINE			QUAN.	RATE	COST		ARR.	DPT.	ARR.	DPT.	MACHINE	START	STOP
PRESENT READING		Coal				Chief Engineer					Boiler No.1		
PREVIOUS "		Wood				1st Assistant					" No.2		
DIFFERENCE		Cyl. Oil				2nd "					" No.3		
KILOWATT HOURS		Eng. Oil				3rd "					" No.4		
FACTORY LINE		Lamps				Oiler					Engine No.1		
PRESENT READING		Packing				Oiler					" No.2		
PREVIOUS "		Sundries				Fireman No.1					" No.3		
DIFFERENCE		Rep. Engines				" No.2					" No.4		
KILOWATT HOURS		" Dynamos				" No.3					Rotary No.1		
		" Pumps				" No.4					" No.2		
		" Boilers									Exciter No.1		
		Wages									" No.2		
											Ice Machine		
											Pump No.		
TOTAL KW. HOURS		Total cost									Pump No.		
SUPPLIES RECEIVED		SUPPLIES REQUIRED				NOTES					Pump M.A.		
						Temp. at 6 P.M.					Pump M.A.		
						Kind of day					Pump		
						Kind of fuel					Pump		
						Quantity of fuel							
						SIGNED							

SUMMARY SHEET, SUGAR FACTORY CENTRAL STATION.

Actual size, 12¾ wide by 11¼ inches high.

and the continual observance of conditions by the men on watch, who otherwise might not notice any trouble until an accident had occurred; besides, the men learn to know better the meaning of the different readings, their relation to each other and to the cost of operation. They learn that it does cost more to supply 50 killowatt hours than 40, and they can know, if they take the trouble to find out, how much more it will cost. In a phrase, it substitutes definite knowledge for indefinite opinions. The daily summary puts in a concise form for record and reference the important parts of the daily log, and is essentially a cost sheet showing the cost of manufacture for the day, and the quantity and value of the product turned out. The monthly and yearly summaries are reports based on the daily summaries and no special blank is necessary. A useful adjunct to the daily log is a curve sheet on which is shown graphically the hourly variation of electricity supplied, coal used, cost, etc. Where electricity is sold, a meter report blank showing fac-simile of meter dials is convenient.

In the purchase and checking of supplies, it is advisable that the requisition shall be made up or approved by the head of the department for which they are needed, and that the orders shall be numbered and

be in triplicate, one to be held at the purchasing office, and the others sent to the seller and the receiving department. On receipt of materials, the order must be checked and returned to purchasing department. To avoid unnecessary clerical work, the orders may be made up in book form, pages being differently colored, three pages numbered alike and the second and third perforated for tearing out. An order blank of this character is shown on this page.

Requisitions for material should be in duplicate and of different colors. The order blank should contain the date of requisition, date of order, and space for noting date of receipt of the material, also

No. 1296 NEW YORK, _____

To. _____

Charge to _____

Render bills charged as above for work done or goods supplied and send IN DUPLICATE TO

BILLS MUST BE RENDERED IMMEDIATELY ON COMPLETION OF WORK DONE OR DELIVERY OF SUPPLIES. Also a statement must be rendered at end of month embodying all unpaid bills to date.

Bills should not be sent to any other address than _____ with above order number.

ORDER BLANK FOR PURCHASE OF SUPPLIES.

Made out in triplicate, one each for purchasing office, receiving department, and seller: original, duplicate, and triplicate are of different colors. Actual size, 5¼ inches wide by 5½ inches high; thin paper.

directions for shipping and charging and the signature of the purchaser. Where the quantity of supplies to be purchased warrants, the chief engineer should present about the middle of each month a complete list of probable needs for the following month, thus allowing ample time for obtaining competitive bids and getting delivery.

The comparison of results is the most difficult and important part of the operation of a plant. Unless the size of the plant is sufficient to permit installation of a scale for coal, photometer for lamps, wattmeters for power, and water meters for water, intelligent and accurate comparison is not possible. A close approximation can be reached by crude devices such as a bin for measuring coal and hourly ammeter

and voltmeter readings, and these must suffice where there is nothing better. The aim of the whole system is to produce results at the least cost consistent with continuous and reliable operation; hence to keep abreast with the state of the art, experiments should be tried where improvements seem possible, and the results carefully noted.

The system of record blanks outlined offers a ready means of noting and comparing results, as the plant is going through a complete test under working conditions every day—a test of greater value than the ordinary test for acceptance or rejection.

The most important items of cost in an isolated plant are usually labor, fuel, and repairs. The comparison of labor cost by the daily summary is self evident. The relative cost of different fuels for a given plant can be accurately determined only where the water evaporated can be measured both as to quantity and temperature, the fuel weighed, and the quantity of waste or ash noted; the latter has a bearing only where its removal costs or where the labor is increased. The cost of repairing and maintaining machinery can be judged only through long experience combined with a complete record of costs.

The system of operation briefly outlined and the blanks shown are the result of practical experience with the slip-shod hit or miss methods in vogue in most plants of moderate size. Frequently the operating engineers oppose the introduction of system in every way possible, as it entails a little more labor and tends to prevent "grafting" and favoritism.

The amount of time required to record the meter readings is not over five minutes in the most extensive plant, unless the gauges are widely scattered; and the preparation of the summary, if the daily logs are properly filled out, is a matter of barely half an hour.

EDITORIAL COMMENT

THE triumph of the Panama Canal project—the fulfilment of the measures which will assure its undertaking and its building—at this writing seems within short and quite definite reach. This (to many unexpected) ending of the long struggle affords one of the most brilliant examples in modern times of the unquenchable vitality of economic truth. The phenomenon indeed is world-old. In one form or another it has attended almost every step in the development of material civilization. The thing which makes for economy, which gives a larger profit return for the unit of energy expended, *will* get itself into being. Nature seems utterly lavish of life and force, but society tends continually to the saving of every foot-pound; the struggle for higher efficiency, larger output, greater intensity of return, goes on often through present disorder and friction and waste, but goes on steadily to the inevitable goal. It is because we saw the Panama Canal to be, beyond all question or comparison, the most efficient means to a vast and long needed economy in the world's traffic, that our faith in its final adoption and completion has held firm from the first.

The triumph is the more brilliant because, first, of the high place of interest to which the world, now awake to its immense importance, has advanced the canal enterprise; and second, because of the apparently crushing series of adversities through which in this case truth has had to struggle into life. It has suffered from reckless extravagance and financial dishonesty; from drastic reorganization and long years of apathy and financial starvation; from calumny and moral assault and battery, by open and secret enemies; from lobbying and political machinations by opposing transportation schemes; from direct and insidious perversion of popular opinion; from the foolish avarice of accredited agents; from obstinacy, prejudice, misstatement, and ignorance; from Senator John T. Morgan and Minister Concha; from the Nicaragua-or-nothing party at Washington, and the blind and greedy politicians at Bogota. It survived, because it was the fittest; Nicaragua, with all its nursing, died because it was unfit to meet modern conditions of economy and efficiency. Let us leave it with its mourners—a few sincere, many hysterical, some bitter. The call of the times is now for the best that the engineering world can give to the construction of the great and long obstructed work.

* * *

ON the political side as on the physical, the problem has outgrown all precedent, and for its solution has required resort to broad underlying principles—the application of fundamental laws which in smaller and more conventional propositions find limited and modified expression. It is the quality of the creative mind—in particular of the engineering mind—to look back of precedent to the data upon which the precedent is founded. To carp at the action of the President in this case as "unprecedented" is as sensible as to condemn the Culebra cut or the Bohio dam. They also are unprecedented,

but for that all the more admirable, because they put into newer, larger, and more serviceable embodiment than ever before the elemental qualities of stability and strength, and serve a larger usefulness than anything that has gone before them.

Speaking of these two very things—Culebra and Bohio—the late George S. Morison once said to me: "You must look at these problems in a large way; when you do, the solution is plain and the difficulties disappear." The controlling conditions for our Government were not the fleeting political configuration of an unstable and equivocal State, but truth to the basic purposes of our Isthmian policy, honesty toward the actual owners in fee of the property we sought to acquire, and faith to our duty to give the world the best possible waterway from Ocean to Ocean. Whatever criticism the President may now receive from those to whom a part seems greater than the whole of our duty—or from those who honestly believe our duty to be something else—if he succeeds in carrying his purpose into execution along those broad and fundamental lines, he will swing his countrymen and the world at large to perception of the soundness of his course, as they have been swung to understanding of the supreme merit of Panama as an engineering project. And he will deserve and receive the praise due to him who sees the Truth behind the Form, and if need be, dares to break through the form to free it.

* * *

THE Ship-Building Trust, as seen in the light of recent disclosures, seems to occupy "that bad eminence"—the climax to the campaign of conscienceless industrial promotion, through which the Napoleons of Finance have been leading their wretched dupes. And the battle which is being fought by the bondholders gives every promise of being the Waterloo of the campaign.

The example is highly instructive—especially for thinking engineers. As a basis for the promotion we find an enterprise of wide reputation and known prosperity. The Bethlehem Steel Works are the very embodiment of the genius and practical wealth-creating talent of a long line of engineers and works managers. They suggest a galaxy of names of which that of John Fritz is the foremost, but of which all are identified with some commanding advance in industrial science. With the entry of the speculative financial "mind," the creative engineering element disappear, but their work lives after them, and this was the bait with which the flotation trap was set for the supposed hordes of hungry investors. The mere savor of profitable business was thought enough to lure them. They are so gullible! So the shining bait was sunk in three or four times its bulk of water. And lest they might get even a taste, the master minds in the swindle planned so to tie up this rich bit that by no chance should the victims get any of it. They were not to have even a dilution of the value they thought they were buying—nothing, but plain water.

The trouble with the execution of the contemplated programme was first that the public had grown very shy, through much hunting, and kept away from the trap; and second, that those who did get caught made such an outcry that helpers came running in, turned on the light, and exposed the entire scheme of high finance most shockingly to the gaze of an unsympathetic public which has since been calling it hard names.

The whole affair supplies another impressive example of the resistless power of economic truth—resistless to crush and sweep away that which contradicts it as to uphold and establish that which accords with it. The trust promoters had almost persuaded the world that finance—the new finance of which they were the discoverers and

high practitioners—was something quite superior to old-fashioned common sense and wholly independent of old-fashioned common honesty. Political economy was obselete. Wealth was no longer to be the product of labor—"accumulated labor." It was a product of the minds of the Napoleons of Finance. It was a capitalization of what labor was expected to produce—or rather of what they could persuade the public to believe labor might produce. The tokens of part ownership in this "wealth" they called, with delicate irony, "securities," and as the volume of the new sort of "wealth" was bounded only by the imagination of the Napoleons, it leaped to the thousands of millions.

It was marvelous—while it lasted. It would have been very beautiful—if it had been true. But after a short era of Aladdinized prosperity, two discoveries, made at practically the same time and dependent one upon the other, upset the whole scheme. The first was a discovery by the people, that the millions called into being by the mind of the financier existed *only* in the mind of the financier. They were different in that respect from the millions created by the genius of the engineer, which have visible physical existence in the form of mines, factories, machine works, and other wealth-reproducing entities. The financiers' millions needed very much bigger figures to count them, but they weighed just exactly as much as the engineers' millions that had been put into them—not one ounce more. And when, as in some cases, they represented nothing that the engineer had done, but only the creation of the "financial genius," it was found that they had no substance at all.

The second discovery was by the Napoleons of Finance. It was extremely simple, but very discouraging to the Napoleonic purpose. It was that their "securities" had become absolutely unsalable. They could issue them—millions of them—but they could not exchange them for a pair of boots. It had been a good game (for the promoters) while it lasted, but the fun was over. Not even the name that was once greatest in Wall Street had any more power. The whole race of Napoleons was discredited, the dynasty outcast. What is saved from their lately dazzling empire will be saved by the engineer. It will be the recovered and restored body of real wealth around which the promoter threw his flimsy and dangerous "industrial" structures.

* * *

WE perceive with surprise and regret that a committee of the American Society of Mechanical Engineers recommends that the yield point be not considered in testing iron and steel, but that the ultimate strength alone be used.

This is not the place to inquire too closely into the reasons which led the committee to take such a peculiar action; doubtless they will be fully explained in the discussion which will be given to the matter at the meetings. Of course it is well understood that the proper determination of the yield point requires the careful operation of the testing machine at such a moderate speed as to avoid the misleading effects of inertia, but we cannot assume that the recommendation of the abandonment of the yield point from the standard specifications has been influenced by any desire on the part of the committee to encourage the operation of testing machines at unsuitably high rates of speed. Possibly some new discovery in methods of testing will be made public, or some hitherto unknown relation between the ultimate resistance and the actual elasticity of the material. We shall await the revelation with much interest, and be most happy to present it to our readers, should such be the case.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE ELASTIC LIMIT OF METALS.

NATURE OF THE CHANGE IN THE MOLECULAR STRUCTURE OF METALS WHEN SUBJECTED TO PERMANENT DEFORMATION.

Society for the Encouragement of National Industry.

THE question as to the real existence of a "yield point" in the case of materials subjected to a stress, has been discussed of late from various standpoints, and in some quarters there has appeared a disposition to dispute the existence of any such stage in the resistance of metals under load. Under these circumstances, the recent investigations of M. Ch. Frémont, published in a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, demand notice and review, showing as they do the behavior of metals when subjected to deforming stresses.

According to the position taken by Lebasteur, the conception of an elastic limit involves the supposition of the existence of a period during which the deformation is instantaneous, a matter upon which a difference of opinion exists. The physicist, by using the most precise methods of measurement, is able to show that permanent deformations are produced by the lightest stresses, and by the use of suitable recording devices M. Frémont has been able to demonstrate that successive applications of slight stresses are able to produce successive small permanent deformations in the frame of a machine intended to be subjected to much larger operative loads.

It is possible, however, to show that although small stresses will produce permanent deformations, the successive applications of small loads will cause these to become smaller and smaller, until no further appreciable set appears. These phenomena, however interesting to the physicist, may therefore be neglected in studying the strength of materials from the viewpoint of the constructor. The existence of an absolute limit of elasticity, is a matter which is contrary to the general experience of mankind, since absolute permanence of any physical structure is hardly conceivable, hence the term should be taken rather as relative to the behavior of the material on either side of such an assumed limit.

According to the French commission for standardizing methods of testing, three definitions of the elastic limit are given: (1.) The theoretical limit of elasticity; this being the maximum load per square millimetre of original section which produces no permanent extension. This limit is supposed to be measured by observing the fact that within a quarter of an hour after the removal of the load the test piece returns to its original dimensions within a thousandth part of a millimetre in a length of 200 millimetres. (2.) The proportional limit of elasticity; this being the point at which the deformations cease to be sensibly proportional to the loads. This limit is supposed to be determined by measuring the extensions to within a thousandth part of a millimetre for successive loads of 1 kilogramme per square millimetre. (3.) The apparent limit of elasticity, or point of origin of deformation under constant load; this being the load per square millimetre of original section under which the extension continues appreciably without the addition of further stress. This limit corresponds to

the drop of beam, or fall of pressure-column in the testing machine. As a matter of fact it is practically impossible to determine exactly the relation of the proportional limit of elasticity to the theoretical limit. By some observers the proportional limit is placed above the theoretical limit, while by others it is stated to be below. M. Frémont gives a number of curves from records of tests showing how such differences of opinion arise from the different behavior of various specimens under test. As a matter of fact, the records of specimens differ under successive increases of load from those obtained under successive decreases, the action in such instances being similar to the behavior of indicator springs under rising and falling pressure tests.

In view of the diversity of opinion regarding the elastic limit, M. Frémont has undertaken to investigate the real action which takes place within a metal under stress, for the purpose of determining what he calls the true elastic limit. As long ago as 1830, it was assumed that a metal had passed its elastic limit when it had undergone a change of texture. At that early date any such change could be observed only after considerable extension had occurred, but with modern methods and appliances, including the use of the microscope in the examination of highly polished surfaces, it is possible to distinguish structural changes much more precisely.

When a substance is non-homogeneous, but is composed of several constituents, each constituent has its own elastic limit, and even when the substance is chemically homogeneous, there may exist several orders, each having its own elastic limit. In practice it is necessary to determine only the minimum elastic limit, as occurring at the moment of the first apparent deformation.

The microscopic examination of materials which have been subjected to stress reveals the fact that some metals show a sudden change in texture with the attainment of a certain stress while others alter their structure gradually as the load is increased. These changes are usually clearly visible if the highly polished surface is examined under a magnifying power of about 50 diameters, and when the sudden change appears the whole surface assumes a granular texture, while for those materials which yield gradually the alteration appears in isolated areas, these gradually merging into each other.

It is well known that when a metal is hammered, pened, rolled, or otherwise subjected to local stresses which exceed the elastic limit, the portions become locally hardened, and this fact has led M. Frémont to consider the effect of partial and localised stresses upon pieces under test. Experience has demonstrated that when a metal is subjected to stress in a testing machine the first deformations are local, and it is this irregular distribution of strain which renders it so difficult to maintain the stress in the exact axis of the test piece, either under tension of compression, there being a constant tendency of the line of stress to shift with the shifting resistance. In order to localise the stresses, so that the true elastic limit may be determined by microscopic observation, M. Frémont recommends the use of a test-piece of diminishing cross section, with the object of localising the maximum stress within a limited area in which the microscopic observations may be made. Numerous photographs of tests upon such pieces showing the extent to which the effects may thus be concentrated are given, under flexure as well as under tension and compression. The whole subject is one which demands fuller examination and discussion than can here be given, but the general conclusions are as follows:

The theoretical elastic limit is the average load per unit of section under which the true elastic limit is attained at a definite point of the piece under test. Its value depends, not only upon the given limitations of elongation and of contraction of section, but also upon the adjustment of the test piece and the precision with which the test is made. It is not the elastic limit of the metal, but only the elastic limit of the special piece under the particular conditions of the test.

The relation of the proportional limit to the theoretical limit of elasticity, is, as has already been said, very indefinite. Its value depends to a great degree upon the local deformations, and in cases in which both tension and compression occur, one may counteract the effect of the other.

The apparent limit of elasticity, the so-called "yield-point," is the average load per

unit of section at which the true elastic limit is reached in all parts of the metal. It approaches more closely to the true elastic limit than does the theoretical limit, but it must not be confounded with it, since the stress is not uniformly distributed over the whole section, owing to the local hardening which takes place under the localization of strains. It is only when the conditions of the test are such that the stress is closely localized, so that marked local hardening cannot occur, that the theoretical and the apparent limits of elasticity agree closely with the true elastic limit.

M. Frémont affirms that there is but one elastic limit for a given metal, the one which he calls the true elastic limit, and this can be determined only by observation, under proper conditions, of the effects of stress in producing strain in the material; such a limit alone having the characteristics of a physical constant. The various elastic limits which it is customary to employ may involve very serious errors, and they should be subordinated to the production and study of discontinuous deformations, which continually occur in practice, under conditions which it is impossible to predict.

MECHANICAL ROAD VEHICLES.

DEVELOPMENTS OF AN IMPORTANT MECHANICAL INDUSTRY IN THE FACE OF UNINTELLIGENT OPPOSITION.

W. Worby Beaumont—Society of Arts.

IN the course of recent Cantor lectures delivered before the Society of Arts Mr. W. Worby Beaumont says some interesting things about the progress which has been made since he addressed the society upon the same subject in 1895, and compares the advantages which existed even then on the Continent with the restrictive ideas which even yet are prevalent in England. At that time, as Mr. Beaumont says, there were but few makers of automobile vehicles, few users, fewer who knew much about them, and no makers in England.

"These things have changed very much since then; there are many makers, very many users. Many or most of the users are well-satisfied owners; and some believe they know more about what a vehicle should be than the makers do. Many of those who do not use them know that no one ought to be allowed to do so.

"Easy and quick transport for man and things is as interesting a problem to-day as it ever has been, even although there is less to learn now than there was in the time of the English pioneers of three-quarters of a century ago.

"A large part of the world is engaged in moving the other part, or in moving things for it. In fact, it may be said that nearly all the world gets its living by moving people, or things or materials of some kind—from the collier who moves coal from its resting-place to the member of Parliament who moves a resolution that automobiles be numbered, and automobilists be hanged, or transported at some rate less than 12 miles per hour."

Since 1895 legislation has modified somewhat the handicap which has hampered the development of the motor-vehicle industry in England, so that mechanical laws have been permitted to control at least some of the limits to progress, instead of being thwarted by unintelligent opposing prejudice. The principal difficulty which appears in existing legislation is the tendency to introduce technical details into a general Act instead of laying down general principles and leaving the working details to be settled by experience.

With the development of the mechanically propelled vehicle in France and Germany popular interest in motor carriages was aroused and since 1896 there has been steady progress. The great mistake which British makers made, however, was their unwillingness to adopt the results of the experience of those who had had greater opportunities.

"They were not satisfied with the best results obtained by our friends across the Channel, and they were misled by the imperfect knowledge they possessed of the means by which those results had been attained. So they commenced to make a new engine or gear and car, or both, that should be, as they thought, better than the

things made abroad. They most of them made scrap instead. A good deal of this was due to the misguided criticism that was frequent in this country, and some of it was also due to the fact that many who were accustomed to steam-engines and traction-engines, and also to gas-engines, imagined that the one thing needful was some simpler form of motor than that they saw either in the Daimler vehicles or the Panhard and the Peugeot, all, or most of them fitted with the Daimler motor. The experience of some years afterwards showed that although there was apparent complication in the governor gear and the apparatus for moving the exhaust valve, as it was found in the Daimler engine, the Panhard and others, the complication was more in appearance than in reality. At all events no engine has been found to run very much better, or continued to run better, than these engines."

The growth of the motor vehicle industry has had an influence upon certain lines of machine work which cannot be too highly estimated, and for the combination of strength, lightness, and high-class workmanship there is nothing which can compare with the results of the efforts of the leading builders of automobiles.

"The motor carriage builder attempted in some matters what the experienced engineer knew to be impossible with the materials employed. This was done in most cases by the amateur who dared, or who in ignorance attempted, what seemed to be a daring thing to the initiated. Failure, however, did not daunt him, and when his gear failed because it was too small for the material he used he did not increase size and weight as an engineer would have done, but called for better and better materials, then for better and better workmanship and better processes, until to accomplish his aims at strength, lightness, power, and speed, he has used and is using materials and workmanship that engineers would only of thought of using for the finest of standards or tools, or for the most costly apparatus of torpedo and gun work. He has called for these things until he has paved the way for the use of materials of extraordinary mechanical properties, and of machine tools and methods which will make the production of the best as cheap as that of the worst. Nothing but the best of everything could have accomplished the feats that have become common since 1896.

"Just as the cycle maker persisted so has the motor carriage maker persisted, and he is doing to-day that which was absolutely impossible only a few years ago. He has stimulated the efforts of the engineer, the machine-tool maker, the metallurgist, the chemist, the india-rubber manufacturer, the textile fabric maker, and the coach-builder. He has, however, only been enabled to do this through the support of the rich purchaser, who, by indulging in a costly sport, has provided the funds which have made possible the development of the vehicle for the many and for trading purposes."

THE REGULATION OF THE MISSISSIPPI.

A DISCUSSION OF THE PROBLEM OF THE BEST METHOD OF CONTROLLING THE FLOODS OF THE MISSISSIPPI.

L. M. Haupt—Journal of the Franklin Institute.

AMONG the various efforts which have been made to direct the great forces in nature for the use and convenience of man, probably none has demanded a greater portion of his energy than those involved in the control of great rivers. The periodical rise of large streams, dependent upon the changes of seasons and climate, has been a matter of study from the dawn of history, and even to-day we are but realizing the plans which were made for the regulation of the Nile as considered by the engineer priests of ancient Egypt. The older methods of river regulation, following early ideas for regulation of all sorts, included the so-called "correction" of the natural course of a stream, assuming that the water did not know what was its best channel, and planning to confine the flow to a narrow and straight way, altogether different from any found in Nature. The modern method, more rational in its conception, seeks to provide suitable outlets for the temporary excess flow, and aims to follow the natural

tendency of the stream, only guiding it in such a manner as to prevent injury to the works of man, to enable it to reach its ultimate discharge to the sea with the minimum of disturbance and the maximum of flexibility.

In the United States the Mississippi river has always been the object of study and effort at regulation, this naturally following because of its magnitude, and the great extent of its drainage basin, and also because of the important section through which it flows. Government commissions have studied it, and large sums of money are yearly appropriated for its improvement and control, and yet it continues to be a cause of danger and destruction with the return of every season of flood.

In an interesting address recently delivered before the Franklin Institute, and published in the *Journal* of the Institute Professor Lewis M. Haupt discusses the methods which have hitherto been employed in the attempts to control the floods of the Mississippi, and indicates in general the existing conditions and methods of treatment.

The natural resource of an individual who seeks to protect his property against floods is to construct an earthen dam, high enough to keep the water out, and in the early history of settlements along the Mississippi, this was the plan adopted by the farmers and planters to protect their property. From the joint efforts of neighboring property holders to extend such dams, the existing system of levees on the lower river has doubtless grown, and while the efficacy of the method in local protection may be admitted, experience with is as a general system has not been encouraging. On the contrary, the result of the elevation of the river banks has been to induce a corresponding elevation in the bed of the stream, the remedy thus working its own defeat.

"It has been said by them of old time, that 'All rivers run to the sea, yet the sea is not full; unto the place from whence the rivers come, thither they return again.' While this is true of the waters of the rivers it is not true of the sediment which they carry. The millions of tons of rain, aided by the frost and winds, denude the mountain fastnesses, so rich in mineral and fertilizing elements, and feed it to the great hydraulic conveyors which transport it to and deposit it upon these garden spots of the earth, built up of the material supplied by the mountains.

"It is stated that since the mouth of the river was at Commerce, just above the Ohio, the deposits have covered some 40,000 square miles, which have been reclaimed from the Gulf and elevated to a height of 285 feet at Cairo, sloping both laterally and longitudinally, so that the river runs on the ridge which it has built up from the bed of the Gulf.

"This feature of alluvial rivers is manifest by a glance at the delta, which so clearly exhibits the process of land structure by the long, tapering salients which carry the several arms of the stream far into the Gulf, instead of permitting it to escape down the shortest and steepest slope to the level of the sea. A cross-section of the river also shows the elevation of the banks to be the highest along the borders of the stream, and that it falls away in the distance at the average rate of about 3 or 4 feet in each mile, so that the overflow drainage is away from the river and into the bayous and swamps which are its natural sedimentation basins.

"It has been estimated that the volume of sediment carried into the Gulf each year varies from 250,000,000 to 278,000,000 cubic yards, but it is also stated that the banks are constantly caving at the rate of about 9 acres per mile of river and that their average height is from 30 to 45 feet, which would contribute about 332,000,000 cubic yards to the bed of the stream, independently of the amount fed by the tributaries, which is no doubt much more, so that the net amount of sediment left in the bed would exceed that deposited in the Gulf, if it be prevented from spreading beyond the bank by levees. Hence it must follow that unless the ejecta are equal to the injecta the excess must contribute to elevation. This may readily be accepted as a fact when it is seen that a single flood may cause deposits on a level amounting to from 6 to 12 inches of mud."

In seeking some other method than the use of levees for protection against disaster by floods, Professor Haupt calls attention to some physical principles, which, while they may appear to be rather ele-

mentary, point the way to relief. In the first place, there can be no overflow if the capacity for outflow be made sufficiently great. In other words, floods are caused because the water cannot get away fast enough. In the second place, the capacity of a stream for the transport of solid matter decreases rapidly with a decrease in velocity. With the diminishing slope of a river, as it approaches its mouth, the sediment which it carries must diminish in size, so that the coarser gravels and shingle are deposited in the upper reaches, and cannot be carried throughout the entire length of the stream and delivered to the Gulf.

Accepting these premises, the true method for relief, according to Professor Haupt, is not to depend upon the production of local scour by local contractions, since these contractions act as dams, checking the discharge from the portions above, and do as much harm as good. Rather, he suggests, remedial measures should be undertaken with the aim of preventing the troubles, instead of attempting to restrain them after they have acquired practically uncontrollable force.

"These remedial measures must evidently be directed towards the prevention of simultaneous floods and accumulation of large volumes of water, which must be carried in a congested conduit for long distances before it can find relief, and therefore no single system will fulfill these requirements but a combination of impounding reservoirs on the tributaries, especially of the western sections, where they may be utilized for irrigation; reforestation of the arid regions; levees with a readjusted alignment and low-weirs at suitable points for spill-ways, to be connected with large subsiding reservoirs in the swampy bayous; and, finally, by the removal of the bars at the delta and opening of all the available and possible outlets to permit of a rapid voiding of the excess of the floods. By such a combination it is believed the navigable channel will be deepened and be made permanent, the flood plane will be lowered and less arable land be inundated, the height of the levees will not have to be constantly increased, the discharge will be retained for a longer period in the lateral basins, from which it may be fed to the main trunk to sustain a nearly uniform stage and water be stored for irrigation, which is already becoming a necessity in the lower valley because of the exclusion of the flood waters by the levees."

POWER GENERATION FROM HEAT.

THE RELATIVE EFFICIENCIES OF VARIOUS KINDS OF FUELS FOR THE DEVELOPMENT OF MECHANICAL ENERGY.

Dr. Carl von Linde—Verein Deutscher Ingenieure.

ONE of the noteworthy papers presented at the recent convention of the *Verein Deutscher Ingenieure* was that of Dr. von Linde, the well-known authority and inventor in the field of artificial refrigeration, and in the general domain of applied thermodynamics. Taking as his broad subject the conversion of the heat produced by the combustion of fuel into mechanical energy, he examined the present existing methods of making this conversion, for the purpose of indicating the most efficient process and the most effective machines to be used in this process. For a century and a half the steam engine has been employed by man to act as his means of compelling the force stored by Nature in combustibles to do his work. Is this machine and this process to continue, or are we on the verge of the replacement of the steam engine by some other form of motor and some other process of force conversion?

While disclaiming the idea of contributing anything new to the discussion of this important question, Dr. von Linde begins by considering the fundamental principles in a very thorough manner, taking the quantity of heat under consideration as represented by the area of a rectangle with an altitude measured up from the temperature of absolute zero, thus plunging at once into the so-called "heat-diagram" without any confusing preliminaries. He thus shows clearly that the first aim in the design of a heat motor is to receive the working medium at the highest possible temperature

and to discharge it at the lowest. At the same time it must be remembered that the lower temperature is not that minimum which can be artificially produced, but that which is determined by natural surrounding conditions. This fact renders it possible to direct attention to the direction in which maximum efficiency must be expected, namely, by the use of high temperatures of reception.

With steam, high temperatures involve high pressures, and hence Dr. von Linde examines, by means of the heat diagram, the performance of simple and multiple expansion steam engines, together with those using highly superheated steam. These show thermal efficiencies reaching up to a little more than 16 per cent., while the use of the heat in the exhaust steam to vaporize a volatile liquid, as in the waste heat engine of Josse and others, enables as high an efficiency to be obtained with old steam engines operated in connection with an auxiliary cylinder as can be secured with a modern engine of the most approved type. Heat diagrams for the steam turbine show that thermal efficiencies of more than 15 per cent. have been attained, and when the mechanical advantages of an engine possessing no reciprocating parts are taken into consideration, this is an excellent showing.

Passing from the steam engine to the various forms of internal-combustion motor, Dr. von Linde shows the inherent advantages of this type of engine, realized in practice by the attainment of an efficiency of more than double that of the best steam engine.

Apart from the higher efficiency of the gas engine as a machine, its use permits the employment of more effective methods of preparing the fuel than is possible with the steam boiler. The gas producer can use a fuel which would be impracticable under a boiler and yet the lean producer gas is especially well adapted for the development of power in the gas engine with a high degree of thermal efficiency. The possibility of utilizing the waste gases from smelting furnaces and coke ovens also adds to the practical efficiency of the gas engine, and thus enables the total thermal efficiency to be accompanied with a corresponding commercial advantage.

The reasons for the high efficiency of the gas engine are several, and these Dr. von Linde proceeds to examine by means of the heat diagram. In the first place, the temperature-range is far higher than is possible with steam, even when superheated at high pressures; and in the second place, the losses due to the initial condensation in steam engines are altogether absent. Dr. von Linde emphasises especially the influence which a high degree of compression exercises upon the efficiency of an internal-combustion motor. The effects of high compression are two-fold. In the first place the higher working pressures permit a smaller engine to be used for the development of a given amount of power, and in the second place the increased combustion pressure is accompanied with an increased temperature, this bringing with it an increase in thermal efficiency due to the greater temperature range. Thus, in the latest gas engines of the Otto type, according to the investigations of Professor Meyer, the total heat in the fuel is divided into three parts, one-third being returned in indicated power, one-third going off with the heat in the exhaust gases, and the remaining third being absorbed in the cooling water of the cylinder jacket. In the case of the Diesel motor, operating with a much higher degree of compression, as much as 42 per cent. of the heat energy in the fuel reappears as indicated power in the cylinder, this being the maximum thermal efficiency which has as yet been attained in any machine for the conversion of heat into work.

Passing to the broader question of the future possibilities for the application of the various forms of heat motors in industrial operations, Dr. von Linde shows that this depends upon other considerations as well as upon the actual thermal efficiency. The development of mechanical energy is not always to be considered by itself, being often involved with the conversion of the latent energy in the fuel into heat and light as well as into mechanical power. The production of heat, like that of electrical energy, involves two factors, volume and intensity, so that we have to deal both with the quantity of heat and with the temperature. Although the actual amount of energy, as expressed in heat units, is the same for a definite quantity of heat, regardless

of the absolute temperature, yet, as has been seen, the efficiency of the processes for the conversion of that energy into mechanical power depends upon the range of temperature which can be employed. In many cases, however, low pressures are necessary for industrial reasons, as in the examples of sugar refining, or of beer brewing, where large volumes of low-pressure steam must be used. The heat available in such instances may be converted into mechanical energy to advantage by the use of such a machine as the waste-heat engine perfected by Professor Josse; or, in many instances higher pressure steam may be first used in a steam engine, the exhaust steam being subsequently employed for heating and evaporating. In such situations it is evident that the superior thermal economy of the internal-combustion motor would not appeal, since the heat for the evaporating machinery would then have to be provided in addition to that supplied for power.

The rapid development of the central station for the generation of light, heat, and power has materially changed the nature of the problem of converting the energy in fuel to the highest advantage. Instead of the single conversion of heat into mechanical energy, there appears the triple transformation into light, heat, and mechanical power, usually through the medium of electricity. Here the use of gas fuel appears to be the best method of attaining the highest efficiency, although up to the present time such installations have not been made on the largest scale. It is possible, however, that the generation of electricity in a central station may not meet all the requirements, since the possession of an ample supply of low-priced fuel gas may lead to the distribution of energy in the gaseous form, the conversion into mechanical energy, into light, and into heat being made at the point of application, by the use of the highly efficient internal-combustion motor, the incandescent gas burner, and the economical, smokeless gas heater.

THE METRIC SYSTEM IN ENGINEERING.

RESPONSES TO QUESTIONS PUT TO THE FRENCH SOCIETY OF CIVIL ENGINEERS BY THE AMERICAN CHAMBER OF COMMERCE IN PARIS.

Société des Ingénieurs Civils de France

ABOUT a year ago there was a paper presented before the American Society of Mechanical Engineers by Mr. F. A. Halsey, discussing the inconsistencies of the countries supposed to have adopted the metric system, and showing that even in France the old measures persisted to a surprising degree. The paper elicited widespread discussion, and drew to the meeting the Director of the Bureau of Standards from Washington, as well as the member of Congress who was most active in endeavoring to push the compulsory adoption of the metric system in the various departments of the Government, and the question occupied a large portion of the time of the convention. The bill for the compulsion of the use of the metric system did not become a law, but the question is still open, and hence the further agitation of the matter is a subject for comment and review. As a sort of sequel to this discussion comes the publication of a series of questions and answers, the former being put by the American Chamber of Commerce in Paris, and the latter supplied by the *Société des Ingénieurs Civils de France;* the whole being published in a recent issue of the *Mémoires* of the Society.

The method of imparting instruction by question and answer is not a new one, but in most instances the questions and answers emanate from the same individual. We can hardly imagine that the residents of Paris who compose the American Chamber of Commerce need themselves to be informed and hence it is reasonable to assume that they have adopted this method of enlightening their brethren across the sea concerning the merits of the metric system. At the same time the subject is elucidated in an interesting way, and some of the points are presented in a clearer manner than has been heretofore published. For the entire catechism the reader must be referred to the original publication, but some of the more important points may here be noticed.

In the first place the inherent superior-

ity of the decimal system of notation is taken for granted, and indeed many people seem to think that there is something inspired about this rather primitive idea. Based, as it is, upon the first crude methods of counting upon the digits of the hands, it is not surprising that it has attained a sort of historical vogue, but this can hardly be taken as a mathematical argument. As the Greek and Roman systems of counting were obliged to give way before the more useful Hindu, miscalled Arabic, system of notation, so, it may well be believed, we shall hereafter employ something still better, possibly based upon the logarithmic progression, and certainly having greater flexibility and scope than the method now in vogue.

Leaving aside, then the responses which tacitly assume that the decimal notation is in itself all-sufficient, we may proceed to a broader consideration of the whole problem. It is admitted, in the answers to the first three questions, that the metre has no definite relation to the dimensions of the earth, and that the metric units of length, weight, and volume possess no precise relation to each other. This eliminates some of the strongest arguments which have been made for the metric system, and clears the air accordingly.

Following these come some curious references to the centigrade thermometer, as if this formed any portion of the metric system. It is, indeed, common for some people to consider that the centesimal thermometer scale belongs to the metric system, but we must confess ourselves surprised to find this position taken by a body of scientific men. If, however, the thermometer scale is to be considered at all, the one which should demand acceptance among the ordinary scales is that of Réaumur, based as it is upon the uniform expansion of mercury, one degree representing 1/1000 of the volume of the bulb, and the number of divisions between two temperatures of water being altogether a secondary consideration. It is generally accepted, however, among scientific observers that the true basis of temperature measurement is that of the expansion of a perfect gas, starting from the absolute zero, so that the thermometer question need not be brought into the discussion at all. There are several side excursions into the popular subdivisions of the coinage of the Latin Monetary Union, but as these relate to the decimal subdivision of the unit, they do not bear upon the main point under serious consideration, that of the difficulties inherent in the general introduction of the metric system into Anglo-Saxon communities. The employment of the nautical mile, and its derivative, the knot, as well as of the fathom, in marine measurements is discussed, and it is maintained that the persistence of the nautical mile is dependent upon the sexagesimal system of angular measurement, the mile being a minute of arc upon the surface of the earth, while when (?) the centesimal system of angular measurement is fully introduced the kilometre will occupy this eligible position. It is, however, admitted, that there is a practical necessity for uniform practice among all marine nations, and hence that system of measurement which is employed by the leading maritime nation of the world must be accepted as a matter of course by those less active on the sea. A similar admission is again made in connection with the use of the carat as a unit of weight by jewellers, this practice being confessed to be due to the necessity of yielding to the practice of the more important nations with which the bulk of the business must be transacted.

When some of the more important matters, relating to the effect of the system of units adopted upon the volume of trade are reached, the responses become less definite, and, indeed, are sometimes rather evasive. Thus, inquiries as to the effect of the employment of the bushel, gallon, and pound, upon the shipment of American goods to France, are met by the response that it is difficult to answer, and that anyhow, the questions of price and quality outweigh such matters. The extent to which the use of the metric system has influenced the importation of manufactured products into France is answered by showing that since 1900 the imports into France from the United States had diminished, while those from metric-using Germany had increased. The influence of the use of the metric system upon the external commerce of France is not stated, nor are the other controlling trade influences of the countries named during the period mentioned. An inquiry as to the extent to which mechanical and other industries were

in existence at the time of the origin of the metric system is met by the statement that at that time France was in a state of upheaval, and not really a fit subject for such a comparison. A better instance is that of Germany, which in 1872 was undoubtedly an active manufacturing and commercial empire, and in which no serious disturbance was caused by the adoption of the metric system. As a matter of fact, Germany was at that time most seriously inconvenienced by the multiplicity of existing arbitrary units, and the replacement of these by a single system naturally proved most acceptable.

We believe that the whole question of systems of weights and measures has been given a consideration altogether beyond its importance. Uniformity is desirable, but not at the expense of more serious matters, and the idea of extolling a means to the dignity of an end is to be deplored. The system which is the best will prevail, and no amount of artificial forcing will cause a defective method to persist. A machine must depend for its success on its merits, its cost, its real value, and not upon the system of measurement employed in its design and construction. The metric system has many advantages, although we believe that these have been exaggerated, and the British system has its defects, many of which have also been magnified. In every case, however, the success of the manufactures and the commerce of any nation must depend upon the intrinsic merits of the goods and the skill of the men, and against these any system of weights and measures sinks into insignificance.

MODERN COKING PROCESSES.

THE REGULATION OF THE COMBUSTION AND DISTRIBUTION OF THE TEMPERATURE IN COKE-OVEN PRACTICE.

D. A. Louis—Iron and Steel Institute.

IN a paper recently presented before the Iron and Steel Institute, Mr. D. A. Louis reviewed the development of modern coke ovens, examining the growth of by-product oven and examining especially the latest improvements in coking practice in the Westphalia district.

The satisfactory coking of coal involves the maintenance of the proper temperature, this temperature depending both upon the nature of the coal and upon the stage in the process of coking.

"There is probably no one who would assert that all kinds of coal should be coked at the same temperature, or that a uniform temperature is desirable throughout the whole of the coking operation, although nobody would contest the fact that the temperature should be distributed appropriately but uniformly whether it be a higher or a lower degree of heat. Hence it is that the regulation and distribution of the temperature in coke ovens have always offered attractive fields to inventors and improvers; and by the middle of last century a whole host of workers had suggested one thing or another to attain the desired end, including burning the washed or unwashed gases in flues around the coking chamber. However, it was Carvès who combined many of these disconnected notions. He investigated the matter sedulously, and found that with the coal he had to deal with—a poor non-caking coal—a high temperature rapidly and evenly distributed throughout the coal in conjunction with closed carbonising chambers, were the conditions for obtaining good coke, and at the same time a good yield of ammonia and tar rich in aromatic substances. It was he who improved the arrangement of the horizontal side flues in which the washed gases were burnt to heat the coking chamber; he too who insisted on the narrow chamber to ensure the desirable rapidity of carbonisation. In the early form the residual gases returned to the ovens were burnt over a solid fuel fire in a grate built for the purpose in the lower part of the walls separating the coking chambers. The heated and burning gases then circulated in two side flues, ascended to the uppermost of the three horizontal flues in the wall, and thence descended these in succession on their way to an inclined flue, which connected the lowest horizontal flue to the subterranean waste main leading to the chimney. In

this scheme the highest temperature was developed under the ovens, and thence decreased in intensity in the order stated, and all the regulation of the combustion and the temperature took place at the grate. Later on the grate was abolished, the heat for the coking being derived wholly from the combustion of the gases, air being admitted under pressure to support the combustion, and therefore by controlling this air supply the combustion and the temperature could to some extent be regulated. Then came the notion that it would be better to supply hot air, and Simon introduced his arrangement in which, by allowing the air for combustion on its way to the ovens to pass through passages running between the underground waste gas mains, the heat from these gases passed to the air, which became intensely heated, and as a result the sole of the coke oven also became so hot that to avoid inconvenience from burning out the two flues of Carvès were replaced by a single flue, made of the most refractory material, so as to stand the heat; the gases then followed the same order of progress as in the old Carvès ovens, and in fact the effects produced in those ovens also obtained in the Simon-Carvès ovens, but in a greatly intensified condition, and would certainly meet with the approval of those authorities who advocate heating in the order indicated, and maintaining the same temperature throughout the whole period of coking."

The horizontal flued oven has passed through a number of modifications, among the most notable of which may be mentioned the Semet-Solvay oven and the Fabry-Linard system. The distribution of heat with horizontal flues, however, was not altogether satisfactory, and hence the vertical-flued system came into use, the first type of this design being due to Coppée. This was followed by the Otto-Hoffman oven, in which there was a violent pre-heating, first both of the air and the gas, but later of the air only. The earlier forms of these ovens were provided with regenerators of brick checker work, but in the later types, such as the Otto-Hilgenstock ovens, a form of Bunsen burner is adopted, there being a concentrated intense combustion at frequent intervals near the bottom of the ovens and a diminishing, although high temperature elsewhere.

The latest types of ovens in use in Germany are those of von Bauer and of Brunck.

"The Brunck ovens resemble other coke ovens in having long chambers supported on a substructure. The Brunck substructure is, however, one of some complexity, as it contains an elaborate series of connecting ducts, cooling channels, checkerwork chambers, and vaulted conduits. These arrangements serve for the removal of the waste gases and for preheating the air supplied for combustion, as well as conducting it to the points where it is required. Moreover, to ensure a better distribution of the heat the ovens are heated from each end independently, hence all the substructural arrangements are in duplicate. The coking chambers are built on the top of an upper row of cooling passages; arched chambers are first constructed, separated by good solid walls, and within these the coking chambers proper are built with a longitudinal flue below each chamber, whilst vertical flues arranged on each side of each chamber with a general longitudinal flue above connect with the lower longitudinal flue below. The lower flue is divided into four sections by parting walls, and a parting wall extending all round the outside of the coking chamber at the centre completely shuts off one side of the surrounding space from the other, and separates the flues of one end from those of the other."

The firing of the Brunck ovens is effected by gas jets at each end, the burning gases ascending the side flues and descending at the centre, the air being heated in a checker-work between the flues. These ovens are provided with a by-product recovery plant, and the waste heat is used for the generation of steam.

The von Bauer oven is another variant of the vertical-flued horizontal oven, somewhat resembling the Brunck design, but rather simpler in construction. The air supply enters between the combustion chambers, the air openings being carefully arranged so as to maintain the combustion exactly at the right points. Each side of the median wall is kept separate from the other, besides which the flues are divided

into groups, the better to permit regulation and control. Each oven can have its temperature regulated separately, and can have its gas directed through the by-product works, or to the gas main, as may be desired. In this way the various stages of coking in each oven may be controlled independently of the others. The charging is effected through the top, and all the advantages of the discontinuous ovens are united with those of the continuous by-product system. Such an oven can produce 170 tons of coke in twenty-four hours with a yield of 74 per cent. of the coal, while the saving of the by-products renders the process a very economical one.

The progress which has been made in the manufacture of coke, from the primitive bee-hive oven to these latest representatives of the by-product continuous oven, is but typical of the development which has been made in recent years in everything connected with the manufacture of iron and steel. The efficiency of every portion of the apparatus has been steadily increased, while at the same time the wastes have been reduced and the by-products utilised while the increased capacity acts to reduce the proportion of general expense, so that the general efficiency of the whole plant is correspondingly affected.

GRINDING AS A MACHINE-SHOP PROCESS.

THE DESIGN AND USE OF THE GRINDING MACHINE AND GRINDING WHEEL CONSIDERED AS MACHINE TOOLS.

C. H. Norton—National Metal Trades Association.

ALTHOUGH grinding has been in use as a machining process for many years, yet its true nature and scientific use still remain to be understood in many establishments. For this reason the paper by Mr. C. H. Norton before the National Metal Trades Association demands notice and abstract, especially in view of the wide practical experience of its writer in this particular department of work.

Mr. Norton reviews the early history of the development of grinding as a machine-shop process, and shows that its original use was as a finishing process to work which had already been brought very close to size in the lathe, and which was ground only with the intention of increasing the accuracy of the product.

"Twenty years ago grinding was considered essential to really good work by concerns that now enjoy the best patronage of the enitre world, and fifteen years ago they had reached the point where it was impossible to produce their work as cheaply without grinding as with it. The best grinding machines of to-day will produce from four to six times more work than those of twelve years ago; and yet, while large numbers of American machine builders are using modern grinding machines, there is a class who demand proofs in the way of tests, etc., before they can believe that grinding is practical for their work. The reason for this condition can be traced to the fact that while there are a large number of grinding machines in use, they are 'universal grinders'; in fact, so familiar has the 'universal grinder' become, that it is very difficult for mechanics to understand that there are now in successful use cylindrical grinding machines that are not universal, and that they do not grind complicated or tool work, but that they do grind *all* cylindrical work that is turned in lathes on *two centers*, and that, contrary to experience with 'universal grinders,' they do remove considerable stock in an economical manner, saving many hours (on single pieces of work) that without their use would be expended in lathe work, for while the grinding machine, as it is generally known, has done accurate work, yet the preparation of work for grinding has consumed as much time in the lathe as if it were to be filed. There are also in use many grinding machines called 'plain grinders' that are simply universal machines with certain parts omitted: yet are no better than universal machines as regards efficiency.

"There is in the mechanical world a common belief that it must consume more time to grind away stock than to turn it away; therefore, we find many insisting that to

grind more than six or eight thousandths from the diameter of cylindrical work must be an expense, and in fact to grind at all must cost more than to turn to size in the lathe."

The modern method of grinding, considers the process from an altogether different point of view. Instead of merely giving a true finish to a piece of work already closely turned to size, the grinding becomes a sizing process, removing appreciable quantities of metal, and altogether changing the routine of machining cylindrical pieces.

"To prepare work for modern commercial grinding, it is simply necessary to turn it to within 1/64 or 1/32 inch of size, and the feed of the lathe can be very coarse, thus reducing the time of turning enormously. Some idea of the time saved by this method can be obtained by noting the time required to turn off a finish chip with a feed of 60 per inch and then the same chip with a feed of 8 per inch. Again note the time taken to turn a piece of work nice and straight to within a few thousandths of size and the time of turning the same piece to within 1/64 to 1/32 inch of size. The saving in time by this method of turning, combined with good grinding machines and wheels, amounts in many cases to from one to eight hours for a single piece of work, and shows a saving of many thousands of dollars when applied to the output of cylindrical work of an entire works. The cost of machines and wheels melts into insignificance before the saving on single pieces."

Viewed in this light the grinding wheel must be considered as a kind of milling cutter, with millions of teeth which cut until they are nearly worn out, and as they wear off are constantly replaced by others equally sharp. That this is really the action of a proper grinding wheel is seen by the appearance of the chips under the microscope. An actual curly chip is seen, and from the sizes and forms of the chips the character of the wheel by which they were made can be determined.

Formerly grinding was considered as a process adapted to small work demanding a high degree of precision, to-day it is employed for finishing a piston rod 12 inches in diameter and 12 feet long with a limit of accuracy of 0.00025 inch. In such a case it is easy to save from three to four days of lathe work with one day's labor on the grinding machine, so that the economy of the process is evident.

"There is a prevailing belief that grinding does not pay except with quantities of duplicate work. Everyday practice proves this belief to be without foundation, and the modern grinding machine, with modern grinding wheels, stands ready to take to a finish still cheaper turning than has yet been done, and we await the more general introduction of heavier lathes to give us still cheaper turning."

FLOW IN CENTRIFUGAL PUMPS.

EXPERIMENTAL RESEARCHES ON THE MOVEMENT OF FLUIDS IN CENTRIFUGAL PUMPS AND ALLIED MACHINES.

James Alex. Smith—Victorian Institute of Engineers.

ABOUT a year ago there was published a paper presented before the Victorian Institute of Engineers, at Melbourne, describing some very interesting experiments made by Mr. James Alex. Smith upon the subject of the flow of liquids in centrifugal pumps. We now have an additional paper, extending these researches still further, and the whole treatment of the question is so eminently practical and scientific as to demand review and comment.

Admitting the existence of numerous analytical investigations regarding the action of centrifugal pumps and similar machines, Mr. Smith sought to demonstrate by ocular experimental methods, the actual occurrences when a liquid is propelled by a revolving wheel in a closed case, and he has devised some very ingenious apparatus for aiding in this study. Taking the facts thus demonstrated he has deduced some conclusions as regards the form of runner best adapted for practical results, the whole forming a combined practical and theoretical study of much interest.

The apparatus used by Mr. Smith consist-

ed of two separate instruments, named by him the vorteximeter and the volutimeter; the first being designed to analyze the vortex or whirl in the runner, the second, the spiral current in a given casing.

"In the vorteximeter fluid, or fluids, are supplied through a revolving shaft to a space separating two glass discs fixed pulley-wise upon the spindle. The discs are kept apart by pieces of card representing vanes. When the general stream outline alone is required a single colored fluid suffices; but when in addition the sliding over each other of integral laminæ is to be followed, two fluids must be used; the greater flow then consists of ordinary water, the lesser of filamentary streams of colored liquid injected into the main issue.

"To measure the forms and motions of streams resulting from a high velocity of rotation, advantage is taken of the fact that the eye is capable of recognizing objects illuminated for an exceedingly short period —certainly less than 1/100,000th of one second—provided the light is of sufficient intrinsic intensity. Hence, if the rotating discs be lighted for a period so short that the angular motion during that time is negligible as compared with the magnitude of the movements to be observed, it follows that the disc will appear at rest. If, further, it is arranged that successive illuminations shall occur when the vanes are in the same relation to a fixed point, and at intervals of not more than one-tenth or one-seventh of a second, then the disturbance of the retina will continue between flashes, and the brain will receive the impression of a constantly illuminated object at rest, if the phenomena observed be constant. If there be a sequence of phases they will blend into a series giving the effect of change in a non-rotating body.

"The speed of rotation of the discs is, of course, a quantity dependent upon the hydraulic problems to be treated, but whatever that speed may be with suitable adjustment, the discs seem stationary, although at low speeds the light may flicker.

"In the volutimeter it has not, so far, been found expedient to rotate the runner. The instrument consists of glass planes separated by paper templets representing the casing to be tested, but the equivalent of the runner is fixed, and with orifices of efflux so designed that the effluent, supplied under pressure, shall at exit pursue a path as nearly as possible coincident with that of the discharge from an actual given runner. Flow is rendered apparent by mixed streams, but special illumination is not requisite."

These instruments are both arranged for use in the projecting lantern, and also adapted for the production of photographic records of the stream-line curves developed under various conditions. In the paper presented last year, a number of reproductions of curves are given, and the experimental side of the subject principally discussed.

The second paper, which has recently been presented, contains the practical discussion of the information obtained by further experiments, showing the influence which they may have upon the design of centrifugal pumps, and materially simplifying the work.

As Mr. Smith says: a centrifugal pump is an apparatus for imparting accelerated motion to a particle and then utilising the resulting momentum to produce pressure. In the design of such machines there are two important questions to be determined, the form of the vane and the section of the runner passage. The pressure head which can be imparted to the water is determined, not by the velocity considered in relation to any part of the runner, but to the maximum absolute velocity; what Mr. Smith calls its projectile velocity in space. The acceleration must be derived from the angular velocity of the runner, and since this must increase with the increment of radius it follows that with uniform rotative speed, radius alone, irrespective of form, governs the velocity of a point in a vane of any contour. This fact, fully confirmed by Mr. Smith's experiments, is of especial interest, since much of the effort which has been given to improve the centrifugal pump has been directed toward the determination of the proper form of vane. There is no doubt that curvature of the vane may alter the distribution of the work, and may serve to deflect the discharge towards a tangent or a radius, but curvature, of itself, cannot cause acceleration, nor can it increase the acceleration due to the circular motion at any point.

Mr. Smith has experimented in his apparatus with runners of various curvatures, both concave and convex, the path of the

particle being photographically recorded in each case, and the results have fully confirmed his argument as to the superior efficiency of the straight radial vane. With this vane the actual path of a particle is the logarithmic spiral, the experimental results being practically the same for speeds ranging between 200 and 2,000 revolutions.

The proportioning of the section of the passage through the runner is governed by the condition that the width should be inversely as the velocity. This condition is met by giving the leading wall of the passage a hyperbolic curve, a result fully confirmed by the experiments.

Reference must be ha! to Mr. Smith's original paper for his detailed conclusions, and also for a description of his "spiragraph," or instrument for tracing curves under conditions similar to those occurring in centrifugal pumps. The methods which he has adopted are both interesting in themselves and valuable for the light which they have thrown upon a problem in machine design concerning which information has been much needed.

ELECTRIC MOTORS FOR PUMPS.

A DISCUSSION OF THE PROPORTIONS OF MOTORS FOR PUMPS AND FANS UNDER VARIOUS CONDITIONS OF OPERATION.

A. J. Bowie—American Institute of Electrical Engineers.

WITH the introduction of electric driving for all kinds of machinery it is most desirable that the capabilities and peculiarities of the motive power should be understood and appreciated by those to whom the arrangement of the whole plant is intrusted. The differences which exist between electric power and steam or other older methods are such as to lead to unsatisfactory results unless proper judgment is used. A special case which demands attention is that in which an electric motor is employed to drive a centrifugal pump or a fan blower, and the especial adaptability of the electric motor for such work renders the question one of interest. In a paper recently presented before the American Institute of Electrical Engineers, by Mr. A. J. Bowie, this subject is discussed in a manner both interesting and valuable.

"The problem of determining the proper capacity of a motor for driving centrifugal pumps and fans, is not always easy to solve. The solution is too often the result of guess-work, and is liable to be seriously in error. In the case of direct-acting pumps working against a known head, the proper motor capacity can be easily calculated. The most economical size of motor for the purchaser, however, may not be solely determined by the possible loads, and their duration, which the motor may be called upon to carry. Particularly is this true where a flat rate system is in vogue and where power is purchased at a price depending upon the rating of the motor and not upon the power actually used. This system of charging for power leads to great abuse in the underrating of motors; on the other hand, it may work a great hardship on a purchaser of power who innocently uses a motor far larger than is necessary and pays for power that is not consumed. Several instances of the latter have come under the writer's observation, and the system in his opinion should be condemned. Where measurements of power are taken at a basis for determining the flat rate, such measurements should be taken under the average running conditions. A variation in these conditions may lead to a very erroneous system of charges in the case of centrifugal pumps and fans, as will be seen.

"For centrifugal pumps and fans the power required for operation at a rated speed and head is by no means all that need be known. One should also know the maximum load which can ever come on the motor when driving the pump or fan at the rated speed and under any possible head. This maximum may be far in excess of the rating."

Three conditions are discussed by Mr. Bowie; constant speed with varying heads changing speed with head varying as the square of the speed, and constant head and varying speed. For each of these equations and diagrams are given, enabling the user to make his computations.

"The behavior of centrifugal pumps may be represented very completely by four curves. These curves are based upon an absolutely fixed speed. Corrections for variations from this speed may be made without difficulty. These curves have, in each case, for abscissæ, the volumes of the fluids delivered in a fixed time interval, while for ordinates they have respectively, head, watts input to pump, watts output from pump, and pump efficiency. The last two curves determine the proper rating of the pump. In general, the maximum efficiency occurs before arriving at the point of maximum output. The proper rating is somewhat indefinite, as will appear from the appended curves obtained in practice. The natural tendency of a manufacturer is to rate his pumps as high as possible. Still, he does not care to go far beyond the point of maximum efficiency at the full load rating."

Probably the case which occurs most frequently in the operation of centrifugal pumps is that of constant head, the speed varying according to the quantity of water discharged. In this case according to the computations of Mr. Bowie, the power varies about as the 3½ power of the speed.

"From this it may be seen what an extremely large effect speed variation has on motors driving centrifugal apparatus. There is perhaps no other form of apparatus so sensitive of change of speed in its power consumption. The effect which a steady pump load has in holding the voltage constant by preventing the racing of generators is thus explained. If centrifugal apparatus be provided with induction or synchronous motors then the speed is practically fixed by that of the prime mover so that the maximum load for the motor with a given pump or fan is determined. Speed control of direct-current motors by variation of field resistance has a limited range in practice and has many points which tend to make it objectionable for the best conditions of commutation. Even at best there will be considerable field distortion at the high speeds. The effect of a load which would increase as the cube of the speed, and even faster would seem to limit still further the allowable speed variation to be obtained in this manner. In view of these facts it is well to provide a motor of ample size for such work and at the same time to see that the field rheostat cannot cut in so much resistance as to overload the motor. As has been shown, the volumetric output of a centrifugal pump varies directly as the speed of revolution. In spite of this fact, many manufacturers rate their pumps at a fixed volumetric output, and publish a list of suitable speeds for different heads under which it may be desired to operate the pump. In some cases the highest speed given in these lists is three or more times as great as the lowest speed. Such misinformation leads to a great deal of trouble and cannot be too strongly condemned."

THE INSTRUCTION OF APPRENTICES.

MODERN METHODS OF TRAINING WORKMEN IN THE ART OF USING TOOLS AND SHOP PROCESSES.

Robert Patterson—Canadian Railway Club.

THERE is no doubt that the apprenticeship question is one of the most important which at present confronts the industrial world.

New tools and improved methods may and do reduce the number of men required to produce a given article, but this very fact creates a wider market and provides work for more men, so that with the increasing field of work more and abler men will constantly be demanded. The old-time seven-years' apprenticeship belongs to a period when primitive methods obtained on all hands, and surely the advances which have been made on all other sides should extend to the process of making workmen as well.

An excellent paper on the training of apprentices was recently presented before the Canadian Railway Club by Mr. Robert Patterson and from this we make some abstracts bearing upon the salient features of the problem.

"The question of instructing apprentices to make good mechanics of them is harder to deal with than in the past. At present

there is a desire among the apprentices themselves to take advantage of present-day opportunities to obtain instruction in drawing and other subjects. Many of the older mechanics, however, who have not had similar advantages, do not like to see apprentices become efficient or able to do a man's work along certain lines, which they are able to do in a great many cases, after having been in the service only a short time. It is this influence exerted over the apprentices with which we have to contend. Being young, the apprentices are easily influenced. Some of the older mechanics, who have not enjoyed the privileges of better education and better system of learning a trade, and who belong to organizations which are not interested in progress, have a tendency to influence the apprentices against their own self-interests. The apprentices are led to believe that employers who wish to educate them and make good men of them have some ulterior object in view. The older mechanics are afraid that the coming generation will be won from allegiance to the unions, and will become more loyal to their employers. They therefore endeavor to create in the minds of the apprentices the idea that the highest object in a trade is to get as much money as they possibly can for their services from the commencement, rather than to become first class workmen, and ultimately merit better wages and higher positions."

Mr. Patterson describes the preliminary examination into the moral, physical, and mental qualifications for a boy to fit him for apprenticeship, these being about the same as would qualify him for trying for an entrance examination to a high school. He also describes what is a very important detail in the methods employed in the shops of the Grand Trunk Railway, the provision of a book of rules for the guidance of the apprentice, showing him the nature of the examinations which he is to pass in the succeeding stages of his career. In each department the apprentice is under the supervision of the foreman, the time for him in the various departments ranging in length according to the importance of the work. Thus in the boiler shop or the coppersmith shop the time may be from six to twelve months; in the machine shop about four years is required, this being divided up into periods of about six months each on the drill press, planer, and vise, about eighteen months on the lathe, and the balance of the time in fitting, steam connections, and minor details, then passing to the erecting shop to complete the five years' course.

A most important feature in the system advocated and used by Mr. Patterson is that the various examinations which are held in the passing of the apprentice from one department to another include instruction in the machines and processes which he is about to undertake, so that a theoretical knowledge of the work is given before the work is begun, and with but a little instruction from the foreman work may be begun at once.

"As at each examination the apprentice is required to make a drawing, it is necessary for him to be instructed in mechanical drawing, and companies and corporations should furnish the means for him to obtain this education, and it should be furnished entirely free. While it is an advantage to an apprentice to get the instruction, it is also an advantage to the corporations to have their apprentices instructed. There should be two classes, one senior and one junior, and it should be made imperative for all apprentices to attend. A roll book should be kept showing the attendance, and this should be carefully scrutinized by the master mechanic, general foreman or person in charge of the works, and tardy apprentices should be looked after. Those who are particularly attentive and show ability should have a term in the drawing office when possible.

"Wages of apprentices is governed largely by conditions and localities, but good fair wages should be paid, so that the best material should be available. Mr. Patterson also believes that as soon as an apprentice has completed his term he should be at once recognized and paid according to his ability. If he is capable of earning the best wages in the shops, he should receive them. If not, he should be paid in proportion. If an apprentice knows that when he is out of his time, if he has ability, he will command the best wages in the shop, it will be an incentive to him to devote all his energies to learning his trade, and make a good man of himself during his term of apprenticeship."

Mr. Patterson discusses the question as to

the legal binding of apprentices, and is led to advocate it, largely because its absence enables unscrupulous employers to benefit by the methods of training to entice apprentices away from the shops where they have been taught, and to which the later and more valuable portion of their services are due.

"Some firms, when they are busy and short of men, find that a boy who has served two or three years is capable of doing their special work, and entice him away, regardless of his moral obligation to complete his apprenticeship. This practice cannot be too strongly condemned. It is bad for the employer, and still more injurious to the apprentice, as it is apt to cause dissatisfaction with wages and with employers. Recommendation or service papers should not be given to any apprentice who leaves his employers before his time of agreed service has expired, unless he is compelled to do so for some special reason which is acceptable to them."

FIRE PROOF CONSTRUCTION.

INFLUENCES OF METHODS OF BUILDING CONSTRUCTION IN PREVENTING THE SPREAD OF CONFLAGRATIONS.

Perez M. Stewart—International Association of Fire Engineers.

PREVENTION is now everywhere accepted as better than cure wherever it can be applied, and in nothing does this hold truer than in defense against fire. In some directions excellent progress has been made in the application of scientific principles to the construction of buildings with respect to the prevention of fire, but the development has been very unequal, and there is much yet to be learned and applied. In a paper recently presented by Hon. Perez M. Stewart before the International Association of Fire Engineers the extent to which modern fireproof construction affords added fire proctection is discussed in a manner which is of serious interest. Mr. Stewart calls attention to the value and importance of experiment stations for the investigation of matters connected with fire insurance, such as the insurance engineering experiment station conducted by the New England Mutual Fire Insurance Companies in connection with the work of the Massachusetts Institute of Technology in Boston, the testing station of the National Board of Fire Underwriters in Chicago, and others, and shows that fire protection is now a well-defined department of the work of the engineer with continually increasing scope.

"A careful consideration of the matter of fire protection should convince every owner that the introduction of safeguards against fire will bring a fair return in reduced rates on the increased outlay, besides fulfilling a moral obligation which he owes to his lessees, tenants, neighbors and himself.

"Several theatres in New York have had their insurance rates materially reduced because of changes in their construction made at the instigation of the Department of Buildings. That the fireproof character of a hotel is a most desirable advertisement is indicated by the fact that some proprietors who cannot honestly claim that characteristic, attempt to deceive their patrons by untrue representations. One of the large hotels of New York maintains a room in a burnt condition as an indication of what can happen in a fireproof hotel without the knowledge of any of the patrons or the proprietor. A fire that originated in this room nearly burned itself out before anyone was aware of it."

An important point upon which Mr. Stewart lays proper emphasis is the inequality in regulations for buildings which, while of different kinds are equally important as fire risks.

"Municipal regulations all over the country provide for almost every contingency which may occur affecting human life in theatres, or other places of public assemblage. Department stores, however, seem to be passed over entirely in the requisites of the City Fathers. Theatres and their management are provided for by a code as long as the moral law. In the case of department stores, however, probably three to five times as many people are allowed to congregate, to the square feet of build-

ing occupied, and yet no adequate provision for their safety is made.

"At the present time, however, many owners of department stores realize not only the moral duty they owe to humanity in safeguarding its interests, but also the benefit they receive in insurance rates by making their stores as fireproof as possible.

"The concentration of commercial interests as embodied in the department store of to-day concerns vitally the fire hazard. Combining an almost infinite variety of industries, the department store represents, so far as the fire hazard is concerned, an aggregation of many individual fire hazards."

Mr. Stewart proceeds to discuss the principles involved in efficient fireproofing, considering the subject from the point of internal and external protection, both in connection with the materials employed and the manner of combining them.

"Among the materials most commonly used in building construction which are generally considered incombustible, may be enumerated the following: brick, stone, terra cotta, wire glass, iron, steel, and concrete. By such incombustible materials is meant those which will not burn or produce flame when subjected to a heat of 2,000 to 3,000 degrees Fahrenheit. Incombustible materials are not necessarily fireproof. It is important that this should be kept in mind.

"By fireproof materials is meant such as not only do not burn, but which, under the action of fire, remain intact and preserve their strength, or the strength of those parts which they protect."

The so-called "slow-burning" system of fireproof construction meets with scant consideration by Mr. Stewart and he cites several instances in which solid wooden construction has been completely destroyed while concrete-protected steel construction withstod the flames. Elevator shafts especially demand protection, since even under the best of cases they naturally become great flues through which fire is transmitted from floor to floor. Vertical passages in walls may often be avoided, but when they are necessary they may be provided with frequent fire stops to break the upward draft.

One of the most important risks in connection with fire protection is found the external exposure, and it is from risks of this sort that the modern fireproof building should be carefully protected. Theoretically the best protection in this respect consists of solid brick walls, but in practice windows and other openings are necessary. Metal shutters, or better, wooden shutters covered with metal, have been adopted, but these have the defect of concealing a fire which may be starting within. A better material is found in wire glass, since this is both transparent and impervious to fire.

Mr. Stewart does not profess to give anything but a bare outline of the modern principles of fire protection, but he has pointed out in no uncertain tones the importance of correct engineering work in the choice and use of materials, and shows very clearly the wide field which the subject affords for study and experimental research.

THE GROWTH OF THE SUEZ CANAL.

A REVIEW OF THE DEVELOPMENT OF A GREAT WATERWAY IN RESPONSE TO THE DEMANDS OF TRAFFIC.

Glasers Annalen für Gewerbe und Bauwesen.

THERE is at the present time an increasing interest in the development of waterways, both internal and international, and a growing belief that water transport will continue to hold its own for all purposes in which economy is a controlling consideration. Since much of the future work to be done in this department of engineering must be guided by past experience, the very full account given in a recent issue of *Glasers Annalen* of the manner in which the capacity of the Suez Canal has been increased is timely and valuable.

The original plans for the Suez Canal, as laid down by the International Commission in 1856, provided for a channel having a total length from breakwater to breakwater of 156,957 kilometres, there being eleven straight portions, ranging from

985 metres to 53,655 metres in length, joined by curves of 5,000 to 15,000 metres radius. The depth of the canal was to be 8 metres, to permit the passage of ships drawing 7.24 metres of water; the width was 80 metres at the surface of the water and 44 metres at the bottom, for the section from Port Said to the northern end of the Bitter Lakes, and 100 metres and 64 metres, from the Bitter Lakes to the Red Sea These dimensions were modified in the actual structure, which, as completed in 1869, consisted of 13 straight portions, with connecting curves of 1,011 to 3,192 metres radius. So far as the cross section was concerned this varied at different points. A number of wide spaces were provided to permit the passage of ships, but the bottom width of the prism was in most places only 22 metres, instead of 44, while the depth varied from 6.71 to 7.32 metres, there being one shallow of 5.49 metres depth, due to the presence of rock.

In 1870 and 1871, after the canal had been in active operation, the channel was deepened by dredging, until the full depth of 8 metres was attained throughout the entire length, and the draught of the steamships traversing the canal ranged from 6.91 to 7.21 metres. The traffic steadily developed, the number of vessels passing in both directions increasing from 486 in 1870 to 1,457 in 1876, the tonnage increasing from 436,609 tons to 2,096,772 in the same period. During this time little or no work was done to improve the canal, but the pressure of the increasing traffic began to be felt, and after the control passed into the hands of the British government it was decided that a million francs should be expended yearly in improvements. It was expected that after 30 years this expenditure would so increase the capacity of the canal as to enable it to provide for a yearly traffic of 10 million tons.

The extension work at first was devoted to the widening and lengthening of the turnout stretches of the canal, thus facilitating the passing of vessels by each other, while at the same time the terminal harbors were improved. From 1876 to 1883 the traffic continued to progress, the tonnage increasing from 2,096,772 in 1876 to 5,775,862 in 1883. During this period the dimensions of the vessels began to show a marked increase, reaching 139 metres length, 15.40 metres in breadth, and 7.50 metres draught. In 1883 153 vessels of more than 7 metres draught passed through the canal, showing the impending necessity for an increase in depth.

In 1883 the so-called "London programme" for the improvement of the canal was discussed, the question being as to the advisability of constructing a second parallel channel or the widening of the existing canal. At first it was suggested that the canal be widened from Port Said to the 130-kilometre station and that a second channel be constructed from thence to Suez. This plan, however, was superseded by a decision to widen the entire channel, the base width being increased from 22 to 65 metres and the depth made 9 metres throughout. This work was intended to permit vessels to proceed at a speed of 8 knots, while the provision of electric lighting would enable traffic to be conducted during the entire 24 hours. The widening was started in 1886, as well as the electric lighting, and in the following year the deepening to 9 metres was begun, this latter improvement having become imperative, owing to the increasing draught of vessels.

Notwithstanding the increased capacity which these enlargements have provided, still further improvements are under way, and the bottom depth is to be 75 metres, with an increase to 90 metres on the curves. The cost of this work is estimated at 101 million francs, and it is expected to provide for the requirements of the next 20 years.

At the present time the maximum speed permitted in the canal proper is 10 kilometres per hour. For a distance of 15 kilometres through the small Bitter Lake this is increased to 15 kilometres per hour, while between the lighthouses in the great Bitter Lake a speed of 22 kilometres is permitted, the distance being 16 kilometres. This gives a possible minimum time of transit of 14 hours, 44 minutes. Before the installation of the electric lighting, in the period from 1876 to 1886, the average time of transit was 41 hours, 56 minutes, of which 23 hours, 37 minutes were consumed in stops at night, so that the actual time of transit was 18 hours, 19 minutes. Since the introduction of electric lighting

in 1886 down to 1900 the average actual time in transit is 16 hours, 48 minutes.

The actual traffic through the canal is fully tabulated from 1884 down to 1900, and the growth is seen to be steady and continuous. Thus the total tonnage in 1884 was 5,871,501, and this had increased to 8,039,175 in 1894, and to 9,738,152 in 1900. That this increase was only possible by reason of the improvements made in the canal is evident from the fact that the total number of vessels in 1900 was only 3,441, while there had been 3,284 in 1884, and as many as 4,207 in 1891, the increased tonnage being mainly due to the greater dimensions of the vessels. Thus in 1884 the largest vessel passing through the canal was of 5,665 tons, while in 1900 the largest ship measured 13,402 tons. The receipts in 1884 were 62,638,964 francs, and this had grown to 90,707,007 francs in 1900.

The continuous growth of the traffic through the Suez Canal and the extent to which increases in capacity have been followed by increases in traffic and in receipts, are ample evidence of the extent to which facilities create traffic. Future waterways in all parts of the world may well be constructed with possible enlargements in view, and just as the harbors of the world must provide ample depth, dockage, and facilities for the continually increasing dimensions of ships, so must ship canals be designed to meet the continual demands for increased capacity which they are certain to create.

THE UTILIZATION OF EXHAUST STEAM.

LOW-PRESSURE STEAM AND ITS APPLICATION BY MEANS OF THE HEAT ACCUMULATOR AND THE STEAM TURBINE.

Julius Divis—Oesterreiche Zeitschrift für Berg und Hüttenwesen.

IN a recent paper upon the steam turbine, published in this Magazine, M. Rateau gave some facts as to the success which he had attained in the operation of low-pressure steam turbines with the exhaust steam from reciprocating engines. This forms a most interesting development in the practice of utilizing exhaust steam, and the method demands attention and discussion in view of its possible importance. The process is discussed in a paper by Inspector Julius Divis, published in a recent issue of the *Oesterreiche Zeitschrift für Berg und Hüttenwesen*, of which we give some review.

M. Rateau has shown that the energy in the exhaust steam of high-pressure engine may be utilized to advantage in a turbine, while at the same time the addition of a condenser enables the effect of the pressure of the atmosphere also to be secured. These facts may be shown, as he has done, by theoretical computations, but the practical application of the system includes some interesting devices. In the first place it has been demonstrated that when properly proportioned, the efficiency of a low-pressure steam turbine operated in connection with a condenser, is very nearly as high as when greater steam pressures are employed, the turbine in this respect differing essentially from the reciprocating steam engine, the efficiency of which falls off to a marked degree with low pressures. There is therefore no difficulty in placing a steam turbine in the exhaust discharge of a reciprocating engine, so far as efficient working with steam pressures of one or two pounds above the atmosphere is concerned, and this M. Rateau has done with success.

The principal practical difficulty encountered in the use of exhaust steam in a turbine lies in the periodical nature of the discharge of the exhaust, especially in the case of large engines operating at slow speeds, such as pumping engines, and the like. This difficulty has been met by M. Rateau in the construction of what he has termed a steam accumulator, a device for the storage of heat and the equalization of pressure. The general construction of this device is readily understood. It consists of a large vertical cylindrical vessel, containing a number of ring-shaped dishes of cast iron, these rings being made very heavy in order to provide a sufficient mass of metal to absorb the heat from the steam. These dishes are so arranged that the exhaust steam is obliged to circulate through and within them and come into close contact with all portions.

The water of condensation which comes over with the steam is directed to passages leading directly to the bottom of the accumulator, so that it may be drawn off, and the whole device forms practically a large steam separator, with the additional feature of the provision of heavy masses of metal for the absorption of heat. The effect of this arrangement is to abstract heat from the highly heated discharge of steam which enters at the beginning of each exhaust stroke of the engine, this heat being again given out to the steam in its passage through the accumulator to the turbine. The result is an equalization of pressure, producing a flow which is very nearly uniform at the discharge, while the return of heat practically equals that absorbed, so that the efficiency of the apparatus is very high. Experiments have shown that with a properly proportioned accumulator the variation in pressure can be kept within such limits that the turbine speed does not vary at most 2 per cent.

With this device, and with the addition of a suitable condenser, the exhaust steam of even a slow-moving pumping engine may be used to high economy in a steam turbine, without interfering in the least with the operation of the original engine. If it is desired to insure operation of the turbine at all times a separate pipe is used, together with a pressure regulator, so that steam from the boilers may be used if the reciprocating engine for any reason is stopped.

Professor Rateau has made various modifications in this apparatus to adapt it to different conditions, and in some cases he advocates the use of an intermediate turbine, the back-pressure of the reciprocating engine being raised to 25 or 30 pounds, and the steam passing through the accumulator to the intermediate turbine and from this to a low-pressure turbine. The lower range of pressure in the original engine thus enables it to work to better advantage, owing to the reduction in cylinder condensation, while the full expansive power of the steam is obtained in the turbines. Such a combination forms a variety of triple-expansion engine, of which the cylinder forms the high-pressure member, while the two turbines correspond to the intermediate and low-pressure elements, respectively.

The various modifications of the principle of the low-pressure turbine operated by exhaust steam are seen to offer great possibilities for the improvement of existing steam plants where the present arrangements cannot well be so materially changed as to permit the installation of an entirely new equipment. In this respect the Rateau system offers points of advantage which in some features render it superior to the waste heat engine of Professor Josse. There is no volatile liquid to be handled and condensed, all the work being done with steam. No difficult packing boxes are required, and the exhaust from the turbine may be discharged into a central condenser, if one is already installed, or any of the independent condensers now on the market may be employed. Apart from these conveniences the turbine does not involve any direct mechanical connection with the engine, but runs independently, both as to speed and power delivery. Indeed, as has been seen, some of its most effective applications have been made in connection with winding and pumping engines, in which the character of the movement is altogether different and with which previous systems of compounding are not always available.

Apart from the application of the low-pressure turbine as an auxiliary to reciprocating engines, the system presents opportunities for convenient arrangements of new plants, using turbines altogether. The present forms of multiple turbines will doubtless be the best for continuous work in large units, where a large expansion ratio and high efficiency are desired. It would be entirely practicable, however, to produce a triple or multiple expansion system in which as many independent turbines would be used, each having its own speed and connections, and each taking the steam from its predecessor until the lowest pressure of discharge into the condenser was reached. It is quite possible that such arrangements may find useful applications where the larger multiple expansion turbines would not be available.

The flexibility which is thus appearing in the application of the turbine principle in steam engineering adds another to its many advantages as a prime mover, and will doubtless hasten the time of its displacement of the reciprocating engine for the great majority of uses as a source of motive power from steam.

EFFECT OF WIND ON ROOFS.

A REVIEW OF THE EXPERIMENTAL INVESTIGATIONS OF IRMINGER AND THEIR INFLUENCE UPON ROOF DESIGN.

Theodor Nielsen—Engineering.

SEVERAL years ago we referred in these columns to the important and interesting experiments of Mr. Irminger upon the action of wind pressure upon various forms of structures, and emphasised especially the suction effect of the wind upon gasholders, roofs, and similar constructions. A further study of this subject appeared in this magazine from the pen of Mr. Robert Neilson, in January of this year, and now we have a paper by Mr. Theodor Nielsen, in *Engineering*, applying the results of Irminger to the study of the actual wind stresses upon roofs.

Until recently it has been customary to assume that wind pressure acted in a manner similar to any other statical pressure, and the data obtained from experiments with wind gauges and similar apparatus have been extended to areas far beyond those upon which the tests were made, in application to the proportioning of the parts of framed structures exposed to wind action. The experiments of Irminger, however, showed that, so far from the action of the wind being a steady pressure, capable of decomposition and resolution like other statistical forces, it produces not only positive pressures, but also negative pressures, or suctions, in directions altogether neglected.

The experiments of Irminger separated the effects of the wind upon the weather and the lee sides, and proved that for planes at sharp angles to the horizon, such as roofs, there is but a small pressure on the weather side, while the lee side is exposed to a heavy suction. These facts render the old theories absolutely worthless, and indicate that in existing designs tons of material have been wasted in rafters, purlins, and ties, while tie bars have been used in the bracing where struts should have been employed, and vice-versa.

Although it is greatly to be desired that Mr. Irminger's experiments be supplemented by others, in order that proper working conditions may be obtained, there is no doubt that his general conclusions are sound; and from his trials Mr. Nielsen has taken certain coefficients and applied them to the computation of the actual stresses upon a roof under the action of the wind In the first place, it is necessary to determine or assume the actual direct pressure of the wind, this being obtained in the usual manner by the employment of wind gauges, anemometers, or the like. Calling this pressure P, certain coefficients are employed to compute the extent to which this pressure is attained on various portions of the structure. On the lee side this coefficient is negative, there being a suction, instead of a pressure, while even on the windward side the actual pressure is but a portion of the total measured force. Thus, according to Irminger's experiments, the pressure on the walls of houses, ventilators, and sheds may be taken as 0.42 P on the windward side, and a suction of 0.36 P on the lee side. For roofs inclined at an angle of 45 degrees the pressure on the weather side is given at 0.22 P at the eaves, and the corresponding suction on the lee side as 0.525 P. These figures indicate the difference between the experimental distribution of pressures and those ordinarily assumed, and show how differently the material should be distributed in order to obtain the maximum resistance to the action of the wind.

Mr. Nielsen gives a complete graphical analysis of the wind stresses on a roof truss, taking both Irminger's data and constants and the distribution according to the ordinary assumptions, so that the differences may readily be compared. The reversal of stress, so important in determining the character and construction of certain members, is clearly shown, and in view of this action, it is no wonder that roofs and similar structures have been damaged by wind, even when most carefully proportioned according to the older methods. According to the new analysis, and in full agreement with practical experience, the wind acts to lift a roof off of the building. According to the old theory the wind ac-

tion may produce total stresses more than double those due to the dead loading, but the new analysis shows a much smaller direct action in most instances, together with a reversed influence upon some members, exposing tie-rods to compression, so that it is astonishing that we have not had more frequent instances of bent and buckled tie-bars. Existing roofs, being calculated according to the old method, are very strong and stiff, so that in many cases the suction simply acts to oppose the dead load. In one instance the mean dead load was 15 pounds per square foot, while the suction was 16 pounds, the two thus nearly balancing each other. In such a case the stiffness of the rafters doubtless prevented the buckling of the tie-rods. A striking example of the suction influence on roofs is given by Mr. Irminger in the case at Copenhagen of a roof, 300 feet by 40 feet, this having been lifted wholly off of the building and deposited in a basin of the harbor, some 100 feet away. An examination of the roof showed that the rafters on the lee side had bent outward, proving the existence of the suction. It is well known that the peasants in Switzerland and other mountainous countries load the roofs of their cottages with heavy stones to prevent them from being sucked or lifted off by the action of the wind upon the lee side of the mountains.

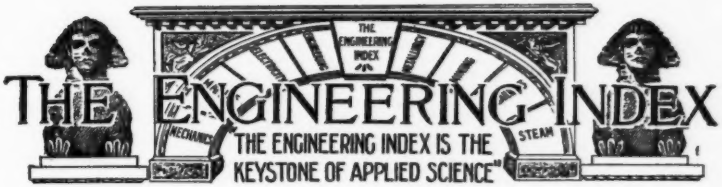
In view of the above experiments and investigations, certain modifications in roof design are suggested, even if the stock of data is not yet complete enough to permit precise formulas to be given. Thus it appears to be advisable never to use any interior tie-rods in a roof truss, but to replace them by stiff sections, capable of acting either as ties or as struts. This precaution may prevent a collapse from a reversal of stress which tie-rods alone would be unable to stand.

According to Mr. Irminger, small flat roofs need not be proportioned for wind pressure at all, the strength required for dead loads being ample, if the precaution is taken to bolt the roof down to prevent it from being lifted bodily upward. For large, flat roofs it is important to consider the suctions on the lee side, since these may cause reversals of stress sufficient to do serious damage. Only for large roofs of halls and similar buildings, and for steep-sided roofs does he consider it necessary to consider the positive wind pressure at all.

These investigations supply explanations for some otherwise mysterious actions of buildings under wind stresses, and should have a marked influence upon details of building design. Thus at St. Louis, during the great hurricane in 1896, various buildings were damaged by the walls bursting outwards, and numerous cases occurred of the outward breaking of windows. Undoubtedly such examples were the result of the combined pressure on one side and suction on the other which has been indicated by the experiments.

There has been much discussion of late as to whether the ordinary estimates of wind pressure have not been excessive. It now appears that they have not only been too large in one direction, but also too small in another. Our structures may not have been too heavy, as has been intimated, but the material may not all have been in the right place.

When these later investigations into the action of wind pressure on structures are considered, it is evident that the whole of the methods heretofore obtaining in engineering practice must be revised. It has been appreciated of late that the results obtained with large wind gauges did not agree with those determined by small gauges or anemometers, however carefully these latter may have been calibrated, but at the same time the pressure, when determined or assumed, was considered as acting positively over the entire area, whereas the modern view shows that the force may be negative at times to an extent capable of reversing the stresses in certain members of the structure. The action upon large covered areas, such as roofs, may be different from that existing with open structures, such as bridge trusses and other skeleton forms of construction. In these cases further experiments may be necessary, but in considering either roofs or the large surface areas exposed to the action of the wind by modern tall buildings, the methods developed by Irminger and worked out by Nielsen and others may well be considered in computing the direction and magnitude of stresses upon the various members.



The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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BRIDGES.

Aqueduct.

The Pecos Valley Aqueduct. An illustrated detailed description of a perplexing piece of engineering work in New Mexico. 1200 w. Ry Age—Oct. 9, 1903. No. 58325.

Arch.

A Great Concrete Arch in Germany. Description and illustration, taken from German papers. The bridge is near the town of Neckarhausen. 600 w. Ry Age—Oct. 2, 1903. No. 58227.

The Adda Railway Bridge in Italy. Notes and illustrations from an article by William Wolff, in *Centralblatt der Bauverwaltung*. An illustrated description of a large masonry arch having a single span of nearly 230 ft. on the line of the Colico-Sondrio Railway in Northern Italy. 1700 w. Eng Rec—Oct. 17, 1903. No. 58465.

The Santa Ana Concrete Arch Viaduct. Illustrates and describes a viaduct 984 ft. in length, in California. 600 w. Ry & Engng Rev—Oct. 10, 1903. No. 58375.

Bascule.

The Ashland Avenue Bascule Bridge, Chicago. An illustrated description. 1600

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w. Eng Rec—Oct. 10, 1903. No. 58345.

Cantilever.

The Substructure of the Mingo Bridge Over the Ohio River. Illustrates and describes a railroad bridge near Mingo Island, which has a cantilever main span 1,290½ feet long, with a clear center span of 700 ft. weighing 6000 tons. The river is subject to floods which demand great stability and strength for the superstructure. 2000 w. Eng Rec—Oct. 3, 1903. No. 58261.

Costs.

Why Steel and Its Erection Costs so Much. Editorial on the results of the bidding for about 40000 tons of steel for the superstructure of the Blackwell's Island bridge over the East River, at New York. 1400 w. R R Gaz—Oct. 2, 1903 No. 58268.

Drawbridge.

A Novel Type of Drawbridge. Illustrates and describes a type of drawbridge adopted by the Miami & Erie Canal Transportation Co. This company has a charter for operating by electric towage, using trolley locomotives on a track along the towpath. Where the track crosses the canal drawbridges are used. 500 w. Eng News—Oct. 22, 1903. No. 58640.

Erection.

Novel Method of Erection Adopted for the Frans Bridge at Villefranche Over the Soane. From *Annales des Ponts et Chaussées*. Illustrates and describes novel methods of erection of a cantilever bridge. 600 w. Eng News—Oct. 22, 1903. No. 58642.

Incline Bridge.

A Movable Railway Incline Bridge at New Orleans. Illustrates and describes a tilting landing stage for the transfer of trains from Mississippi boats to the tracks of the Texas & Pacific Ry. It is a trussed bridge, fixed at the shore end, but capable of a wide range of adjustment at the river end. 2700 w. Eng Rec—Oct. 24, 1903. No. 58626.

India.

Bridge Over the Rupnarayan (*Pont sur le Rupnarayan*). Illustrated description of a bridge on the line of the railway between Calcutta and Madras. 1000 w. 1 plate. Génie Civil—Sept. 26, 1903. No. 58503 D.

Erection of the Girna Bridge, India. An illustrated account of engineering work of exceptional interest, including sinking of piers and erecting superstructure. 1600 w. Engr. Lond—Sept. 25, 1903. Serial. 1st part. No. 58214 A.

Inspection.

Method of Making Annual Inspection of Bridges and Culverts. Abstract of report of committee of the Association of Railway Superintendents of Bridges and Buildings, presented at Quebec, Canada, Oct. 20-23, 1903. 3800 w. Eng News—Oct. 29, 1903. No. 58677.

Long Span.

The Marietta Long-Span Highway Bridge. An illustrated article, the present number dealing with the stresses, dimensions and deflections of this new bridge across the Ohio River. 3000 w. Eng Rec—Sept. 26, 1903. Serial. 1st part. No. 58138.

Newcastle.

A New High-Level Bridge Over the River Tyne at Newcastle, on the North-eastern Railway of England. F. E. Harrison. An illustrated detailed description of the construction of a four-track structure. 3800 w. Ry Age—Oct. 23, 1903. No. 58661.

New York.

The Comparative Strength of East River Bridges; Existing and Proposed. Letter from W. Hildenbrand, with response from G. Lindenthal concerning the bridges across the East River at New York. Ill. 4500 w. Eng News—Oct. 1, 1903. No. 58183.

Railroad Bridge.

The Pennsylvania Railroad Bridge over the Raritan River at New Brunswick, N. J. An illustrated detailed description of the construction of a fine bridge, with brief review of the removal of the old bridge to a new site without interrupting traffic. Also editorial. 5000 w. Eng Rec—Oct. 10, 1903. No. 58341.

Repairs.

The Kansas City Flow-Line Bridge Repairs. J. A. L. Waddell. A statement, with illustrations, concerning the repair work to the bridge over the Kaw River that carries the pipes for the water supply of Kansas City, which was badly injured by the flood. 5500 w. Eng News—Oct. 29, 1903. No. 58678.

Suspension.

The Vernaison Suspension Bridge. Emile Guarini. Illustrates and describes a semi-rigid suspension bridge of light construction, crossing the Rhone 8½ miles below Lyons. 700 w. Sci Am Sup—Oct. 10, 1903. No. 58371.

Transfer.

The Movement of the Passy Bridge (Le Déplacement de la Passerelle de Passy, J. Feugères. An illustrated description of the manner in which the highway bridge across the Seine between Passy and Grenelle was moved bodily a distance of 29 metres. 2000 w. Génie Civil—Sept. 19, 1903. No. 58500 D.

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Viaduct.

The Concrete Viaduct Near Riverside, Cal.; San Pedro, Los Angeles & Salt Lake R. R. A. C. Ostrom. Illustrated description of the arched viaduct crossing the Santa Ana River. 1000 w. Eng News—Oct. 22, 1903. No. 58632.

CANALS, RIVERS AND HARBORS.

Breakwater.

Final Completion of the Buffalo, N. Y., Breakwater Extension to Stony Point. Illustrations of what is claimed to be the longest breakwater system in the world, with facts concerning it. 350 w. Eng News—Oct. 1, 1903. No. 58179.

Canal Traction.

Electric Traction on Canals. (Le Halage Electrique sur Canaux.) Georges Petit. A review of the applications which have been made of electric power to canal traction, showing the conditions under which it may prove advantageous. 3000 w. Revue Technique—Sept. 25, 1903. No. 58509 D.

Cranes.

European Floating and Dock Cranes. Frank C. Perkins. Illustrated description of cranes used in Hamburg harbor. 900 w. Sci Am—Oct. 3, 1903. No. 58174.

Shipbuilding Cranes at Kiel. Illustrated descriptions of cranes in use in the Krupp shipyard at Kiel. 1100 w. Engr, Lond—Oct. 9, 1903. No. 58442 A.

20-Ton Steam Jib Crane. Illustrated description of a type in operation on the new harbor works at Dover. 1000 w. Engr, Lond—Oct. 2, 1903. No. 58305 A.

Dams.

The Correct Design and Stability of High Masonry Dams. George Y. Wisner. Prepared for the Nat. Irrigation Cong. Discusses the problem of constructing dams to withstand the great pressure of water stored for the irrigation of arid lands. 3000 w. Eng News—Oct. 1, 1903. No. 58185.

Erie Canal.

Summary of the Case Against the Erie Canal Enlargement. Editorial review of the arguments that have been advanced. 1800 w. R R Gaz—Oct. 23, 1903. No. 58646.

The Opinions of Engineers on the New York Barge Canal Proposition. Editorial, with letters from prominent engineers in reply to a request for their opinions. 9000 w. Eng News—Oct. 22, 1903. No. 58638.

Floods.

Controlling the Floods of the Mississippi River. Prof. Lewis M. Haupt. Considers the great destruction of life and property by these floods, and gives suggestions of remedies that may be applied to alleviate the disasters. 5000 w. Jour Fr Inst—Oct., 1903. No. 58289 D.

Flood Damage to Bridges at Paterson, N. J. An illustrated article showing the condition of bridges after the flood, and discussing points of interest to engineers. 1600 w. Eng News—Oct. 29, 1903. No. 58675.

Flood Prevention and Irrigation: Twin Ideas. J. R. Burton. Urging that measures be taken to control flood waters, and that the stored waters be used for land irrigation. Considers methods involved. 4000 w. N Am Rev—Oct., 1903. No. 58286 D.

The Floods in the Passaic Valley. Editorial on the destruction caused by the recent heavy rainfall, with remarks on the need of immediate investigation and remedy. 1000 w. Eng Rec—Oct. 17, 1903. No. 58464.

Haulage.

Recent Canal Haulage Improvements. George E. Walsh. Considers recent electric haulage systems, and the general tendency. 1800 w. Ir Age—Oct. 29, 1903. No. 58665.

Kiel.

The Baltic Canal. An examination of the commercial and financial deficiencies of the Kiel Canal, showing the causes to be the low charges and high expenditures. 1000 w. Engr, Lond—Oct. 2, 1903. No. 58303 A.

Lighthouses.

See Gas Works Engineering.

Pier.

Completion of Roker Pier. Illustrated description of a pier, begun eighteen years ago, on the coast of England. 600 w. Engr, Lond—Sept. 25, 1903. No. 58216 A.

The New Roker Pier, Sunderland. General view, plan and sections of a pier which forms one arm of the harbor at the mouth of the Wear. 700 w. Engng—Oct. 2, 1903. No. 58295 A.

Ship Canal.

The Suggested Forth and Clyde Ship Canal. Benjamin Taylor. A survey of the rival schemes for the construction of a deep water ship canal between the Forth and the Clyde. 4500 w. Page's Mag—Oct., 1903. No. 58470 B.

Suez.

The Suez Canal and Its Improvements (Der Suezkanal und seine Verbesserungen). An account of the various improvement works which have been made upon the Suez Canal since its opening, with a table of the traffic. 3500 w. Glasers Annalen—Oct. 1, 1903. No. 58523 D.

Torrents.

The Reforestation of Mountains (Le

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Reboisement des Montagnes). A discussion of the regulation of mountain torrents showing the influence of forests upon the distribution of rainfall and the importance of forest preservation and cultivation. 2000 w. Génie Civil—Sept. 26, 1903. No. 58501 D.

Traffic.

Traffic of European Rivers and Canals. Ray G. Floyd. An illustrated article giving information obtained on a tour of inspection of European waterways. 1700 w. Marine Rev—Oct. 8, 1903. No. 58309.

CONSTRUCTION.

Building Construction.

The Twenty-three Story Land Title Building, Philadelphia, Pa. The first article deals especially with foundations, wind-bracing, etc. An illustrated detailed description. 3300 w. Eng Rec—Oct. 3, 1903. Serial. 1st part. No. 58259.

Fireproof.

Fireproof Construction. Hon. Perez M. Stewart. Discusses some phases of modern methods, materials, etc., outlining the essentials in fireproof construction. 4000 w. Am Archt—Oct. 24, 1903. No. 58655.

Foundations.

Action of Sea Worms on Foundations in Boston Harbor. F. W. Hodgdon. Brief illustrated description of the destruction of timber from the outside by worms. General discussion. 3200 w. Jour Assn of Engng Socs—Aug., 1903. No. 58167 C.

Interlocking Metal Piling for Power House Foundations. An illustrated description of coffer dams of unusual construction used by the Union Electric Light & Power Co. of St. Louis in building their power house. 900 w. Eng Rec—Oct. 24, 1903. No. 58628.

Roads.

Latest Progress in Good Roads Construction. Waldon Fawcett. Gives illustrated description of improved machinery, of great power and efficiency, used in the construction of roads. 1400 w. Sci Am—Oct. 3, 1903. No. 58175.

Trench-Work.

Rock Trench-Work, Boston, Mass. Frederick I. Winslow. Brief account of the conditions and practice in this city. 500 w. Eng News—Oct. 22, 1903. No. 58636.

Tunneling.

A New Method of Tunneling Under Broadway, New York. Illustrated description of the system adopted which will cause but little interruption of traffic and present no serious obstacles in the street. 1400 w. Eng Rec—Oct. 24, 1903. No. 58627.

Tunnels.

Harlem River Tunnel of the Rapid Transit Subway. Illustration and description of a difficult piece of engineering work carried out on a new system through difficult material. 1200 w. Sci Am—Oct. 31, 1903. No. 58680.

The East River Division of the Pennsylvania R R. Tunnel at New York City. Illustrates and describes the construction under the East River to Long Island. 1500 w. Eng News—Oct. 29, 1903. No. 58676.

The New York Terminal of the Pennsylvania Railroad. The first of three articles giving an illustrated description of this great undertaking. 2300 w. R R Gaz—Oct. 9, 1903. No. 58349.

The New York Terminal of the Pennsylvania Railroad. The present article illustrates and describes the tunnels to be constructed from the middle of the North River under Manhattan and the East River to Long Island City. 2000 w. R R Gaz—Oct. 16, 1903. No. 58398.

The Pennsylvania Railroad Tunnel Under the North River, at New York City. An illustrated article describing the portion of the line in the North River division. 8000 w. Eng News—Oct. 15, 1903. No. 58403.

Tunnels for the New York City Terminus of the Pennsylvania and Long Island Railroads. An illustrated article describing the plans for this extensive undertaking. The tunnels under the North and East rivers, and the great terminal station forming the most costly and stupendous engineering work for passenger traffic in the history of railroading. 3800 w. Eng Rec—Oct. 10, 1903. No. 58344.

Tunnels for the New York City Terminus of the Pennsylvania and Long Island Railroads. An illustrated description of the East River division of this system, with general matter and illustrations. Also editorial on the specifications. 4000 w. Eng Rec—Oct. 17, 1903. No. 58466.

Wind Pressure.

Effect of Wind on Roofs. Theodor Nielsen. Explanation of a new theory based on the experiments of J. O. V. Irminger. Ill. 3500 w. Engng—Oct. 9, 1903. No. 58437 A.

The Influence of Wind Pressure upon the Stability of Chimneys (Die Grösse des Winddrucks bei der Berechnung der Standsicherheit von Schornsteinen). H. Claussen. A discussion of the positive and negative pressures due to wind action, showing the manner in which existing data may be used for chimneys. 2000 w. Glasers Annalen—Oct. 1, 1903. No. 58524 D.

The Influence of Wind Stresses upon

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the Verticals of Framed Structures (Der Einfluss der Windverspannungen auf die Einspannungsmomente der Ständer Eiserner Wandfachwerke). L. Geusen. Discussing especially the wind stresses on the verticals of continuous bridge trusses. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1903. No. 58520 D.

MATERIALS.

Asphalt.

The Asphalt Industry of Trinidad. Abstract of the report of the Royal Commission concerning the asphalt industry at La Brea. 2000 w. Ir & Coal Trds Rev—Oct. 9, 1903. No. 58430 A.

Brick.

Silica Brick Making. F. C. Downing. An account of this industry in various countries, with description of the raw material, and method of manufacture. 4000 w. Brick—Oct., 1903. No. 58316.

Building Materials.

Calcareous Brick and Stone Manufacture in Germany. A report concerning these industries, with illustrations of machines used, describing processes, etc. 3300 w. U S Cons Repts, No. 1765—Oct. 3, 1903. No. 58220 D.

Building Stone.

The Weathering of Building Stone in London. An illustrated article on the decay of building stones in large cities, especially in London, with discussion of some of the causes. 2400 w. Quarry—Oct., 1903. No. 58377 A.

Cement.

Certain Vexatious and Fallacious Cement Tests Now in Vogue. D. B. Butler. Read before the Soc. of Engrs. Discusses methods and gives standard specifications for general purposes. 3000 w. Engr, Lond—Oct. 16, 1903. No. 58487 A.

Portland Cement Manufacture. Edwin C. Eckel. Considers the preparation of slag-limestone mixtures. 1700 w. Munic Engng—Oct., 1903. No. 58232 C.

Testing Methods in the Physical Examination of Portland Cement. A. H. Cederberg. Gives results of methods pursued and observations made in 6,238 tests of samples made during the last four years. 2700 w. Min & Sci Pr—Oct. 3, 1903. Serial. 1st part. No. 58333.

Concrete.

Mixing and Placing Concrete Composition. S. H. Lea. Information concerning the Physical characteristics of its ingredients, proportions best suited for different purposes, hand mixing, etc. 6400 w. Mines & Min—Oct., 1903. Serial. 1st part. No. 58148 C.

Some Methods and Costs of Concrete Mixing on the Buffalo, N. Y., Breakwater. Emile Low. Gives information as to the kind and size of mixers used, quantity and quality of concrete, cost, etc. Ill. 2500 w. Eng News—Oct. 8, 1903. No. 58353.

Enameled Brick.

A Method of Making Enameled Brick. Lawrence E. Barringer. Describes the work of making white enameled brick of good quality, as developed by experimental investigations, and notes facts of interest and value brought out. 3000 w. Brick—Oct. 1, 1903. Serial. 1st part. No. 58315.

Granite.

Tests upon Granite Blocks for Arch Hinges (Versuche mit Granitquadern zu Brückengelenken). C. Bach. Data and results of compression tests of granite, showing the wide variations due to weathering, etc. 7000 w. 3 plates. Zeitschr d Ver Deutscher Ing—Oct. 3, 1903. No. 58517 D.

Reinforced Concrete.

A Roof on the Melan System (Eine Ueberdachung nach Bauweise Melan). Illustrating and describing a flat arched roof of 18 metres span over a hall in Vienna. 1800 w. Beton u Eisen—4 Hefl, 1903. No. 58540 H.

Concrete Re-enforcement. Julius Kahn. Illustrates and describes a system of concrete re-enforcement designed to resist vertical shear, stating the principles of the type recommended. 2500 w. R R Gaz—Oct. 16, 1903. No. 58399.

Construction of a Well in Reinforced Concrete 20 Metres Deep (Erbauung eines 20 M. tiefen Brunnens aus Eisenbeton). L. Zöllner. Describing the sinking of a well 8 metres in diameter, 20 metres deep, lining it with reinforced concrete walls. 1000 w. Beton u Eisen—4 Heft, 1903 No. 58542 H.

Origin and Development of Armored Concrete. An account of a lawsuit in France concerning the Monier and Hennebique patents, and also the patents of other inventors. 800 w. Engr, Lond—Oct. 9, 1903. No. 58441 A.

Regulations in Regard to the Use of Concrete Steel. Issued by the Bureau of Buildings, Borough of Manhattan, New York. Also editorial. 2200 w. Eng Rec—Oct. 10, 1903. No. 58343.

The Determination of the Lines of Influence in a Beam Secured at One End and Free at the Other (Bestimmung der Einflusslinien eines Trägers welcher an dem ein Ende Eingeklemmt ist und aus anderen Ende Frei Aufliegt). Prof. Ramisch. A mathematical analysis for an overhung beam of reinforced concrete. 2500 w. Beton u Eisen—4 Heft, 1903. No. 58546 H.

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The Eggert Ceiling (Eggert Decke). Describing a flat combination floor and ceiling in reinforced concrete, with data and illustrations of tests. 1500 w. Beton u Eisen—4 Heft, 1903. No. 58543 H.

The German Municipal Exposition in Dresden, 1903 (Die Deutsche Städte-Ausstellung in Dresden, 1903). H. Bastine. Giving illustrations of a variety of reinforced concrete structures erected on the exposition grounds. 2500 w. 1 plate. Beton u Eisen—4 Heft, 1903. No. 58544 H.

The Use of Reinforced Concrete Piles for the Foundation of the Berlin Court House (Die Gründung des Amtsgerichtsgebändes auf dem Wedding in Berlin mit Betoneisen pfählen). H. Hertel. Describing the construction of the piles and the method of sinking them. 3500 w. Beton u Eisen—4 Heft, 1903. No. 58545 H.

Water Conduits and Sewers in "Sidero-Cement" (Conduites d' Eau Egouts Cylindriques en "Sidero-Cement"). Describing large concrete mains with longitudinal and circumferential reinforcements of round rods and rolled sections. Serial, Part I. 2000 w. Beton u Eisen—4 Heft, 1903. No. 58541 H.

MEASUREMENT.

Current Meters.

Vertical and Inclined Current Meters (Der Normal und Schiefgestellte Hydrometriche Flügel). H. Lauda. An elaborate discussion of the calibration of current meters of the Woltmann mill type for measuring the flow of water in streams, showing the influence of position upon the readings. Two articles, 8000 w. Oesterr Wochenschr fd Oeff Baudienst—Sept. 19, 26, 1903. No. 58577 each D.

Surveying.

An Improved Mining Compass (Ein Neues Zulegzeug). O. Nowotny. Describing an improved instrument for running lines in mining work and especially adapted for convenient use underground. 1000 w. Oesterr Zeitschr f Berg u Huttenwesen—Sept. 19, 1903. No. 58550 D.

General Instructions to Locating Engineers. Issued by William Ashton, Resident Engineer, Oregon Short Line R. R. 1200 w. Eng Rec—Oct. 24, 1903. Serial. 1st part. No. 58630.

Topography.

Topographic Work in the Grand Canyon of the Gunnison. I. W. McConnell. An illustrated article giving facts brought out by surveys and explorations made to determine the possibility of diverting the water from the Gunnison River into the Uncompahgre Valley. 2500 w. Eng Rec—Oct. 3, 1903. No. 58260.

MUNICIPAL.

Garbage.

Baltimore's System of Garbage Disposal. Describes and illustrates a recently constructed plant having new features. 700 w. Sci Am—Oct. 31, 1903. No. 58681.

Lighting.

Costs and Prices of Gas and Electric Lighting by Municipal Plants. Alton D. Adams. Considers 18 cities and towns in Massachusetts. Also editorial. 3800 w. Munic Engng—Oct., 1903. No. 58233 C.

Park.

Revere Beach Reservation of the Metropolitan Park System, Boston. H. J. Kellaway. An illustrated article describing the improvements made at a Boston resort. 2000 w. Eng Rec—Oct. 24, 1903. No. 58625.

Pavements.

Some Observations on Street Pavements. S. Whinery. The present article gives statistics showing the importance from the financial standpoint, and the need of scientific study of the subject, suggesting the lines most profitable, and considering the endurance of pavements, construction, etc. 5500 w. Eng News—Oct. 22, 1903. Serial. 1st part. No. 58639.

The Six-Inch Macadam Streets of Hudson, N. Y. H. K. Bishop. An illustrated article giving an account of the street improvements and describing the method of doing the work, giving cost. Also letter and editorial bearing on this subject. 3300 w. Eng News—Oct. 8, 1903. No. 58352.

Pipe Galleries.

Pipe Gallery Experience. James C. Bayles. A summary of experience with pipe galleries in cities, showing their advantages. 3800 w. Dom Engng—Oct. 24, 1903. No. 58656 C.

Refuse.

The Disposal of New York's Refuse. An illustrated account of methods in use, with some references to past methods. 2300 w. Sci Am—Oct. 24, 1903. No. 58649.

Sewage.

A British View of the Bacterial Treatment of Sewage. Dr. Samuel Rideal. Abstract of a paper before the International Cong. of Hygiene at Brussels. Gives conclusions based on careful study. 1200 w. Eng News—Oct. 22, 1903. No. 58643.

Sewage Purification Plants for Summer Cottages. John W. Alvord. Shows how modern improvements in the septic tank can be adopted for summer resort cottages at small cost. Ill. 600 w. Sci Am Sup—Oct. 17, 1903. No. 58413.

The Design of Works for the Bacterial Treatment of Sewage. Stuart H. Davies. A discussion of the most important points in the design of works, with general con-

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sideration of the subject. 2700 w. Engng —Oct. 9, 1903. No. 58436 A.

Streets.

Difficult Street Intersections. An account of the plans used in Duluth, Minn., on steep grades. 2000 w. Eng Rec—Oct. 24, 1903. No. 58629.

WATER SUPPLY.

Analysis.

Field Methods of Water Analysis Adopted by the United States Geological Survey. An authorized statement obtained through the courtesy of Mr. F. H. Newell, Chief Engineer. 600 w. Eng News—Oct. 22, 1903. No. 58637.

The Significance of Bacteriological Methods in Sanitary Water Analysis. C. E. A. Winslow and C. P. Nibecker. Discusses the significance of chemical analysis and bacteriological examinations, describing tests and giving results of studies. 5000 w. Tech Qr—Sept., 1903. No. 58385 E.

Denver.

The Cheesman Dam and Other Works for the Water Supply of Denver, Colorado. An illustrated description of a masonry dam under construction. 4300 w Eng Rec—Oct. 24. 1903. No. 58624.

Ground Water.

Conservation and Increase of Subterrean Water. E. O. Mawson. Considers the means by which this source of water supply may be conserved and increased. 4300 w. Engr, Lond—Oct. 9, 1903. No. 58439 A.

Mains.

Moving a 48-in. Force Main Under Pressure, at Philadelphia. Seth M. Van Loan. Outlines the reasons why the undertaking was necessary, showing the conditions during the progress of the work, and describing the main features. 1000 w. Eng News—Oct. 8, 1903. No. 58354.

Meters.

The Methods and Cost of Installing Meters at Cleveland, O. Information from papers by Edward W. Bemis, and from the annual report. 1800 w. Eng News—Oct. 22, 1903. No. 58641.

New York City.

Progress Report of Commission on Additional Water Supply for New York City. The first report of the Commission setting forth the main conclusions reached, with editorial. 9200 w. Eng News—Oct. 1, 1903. No. 58184.

Quality.

Potable Waters in Southwest Lancashire. J. Campbell Brown. Considers the quality of the surface waters, deep wells and spring waters, giving results of analysis. 1500 w. Engng—Oct. 2, 1903. No. 58298 A.

The Supply of Towns with Potable Water (L' Alimentation des Villes en Eau Potable). F. Diénert. Discussing especially the causes of pollution and the best methods of purification, including various systems of filtration. 5000 wd. Rev Gen des Sciences—Oct. 15, 1903. No. 58531 D.

Sand Washers.

Sand Washers at the Roxborough Filters, Philadelphia. Illustrates and describes interesting features introduced in these plants. 1500 w. Eng Rec—Oct. 10, 1903. No. 58342.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic Systems.

The Home Telephone Company, Dayton, Ohio. An illustrated description of a large automatic exchange recently inaugurated. 2500 w. Elec Rev, N Y—Oct. 24, 1903. No. 58621.

The Prött Automatic Telephone System (Das Fernsprech Nebenstellensystem von Prött). Dr. K. G. Frank. Describing a variety of automatic telephony in which groups of subscribers are connected with each other from the central station. 3000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58559 B.

Cables.

Laying the New Block Island Cable. Illustrated description of the work of laying eleven miles of heavy cable connecting Block Island with the mainland of Rhode Island. 1200 w. Elec Rev, N Y —Sept. 26, 1903. No. 58123.

Glasgow.

The Glasgow Municipal Telephone System. The first of a series of articles giving facts and figures on capital cost. 2200 w. Elec Rev, Lond—Oct. 9, 1903. Serial. 1st part. No. 58422 A.

Multiple System.

The Rowland Multiple Telegraph System (Uber den Rowlandschen Vielfachtelegraphen). H. Tuck. A fully illustrated account of the Rowland apparatus by which eight messages are sent simultaneously over a single wire. The system is in operation between Berlin and Ham-

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burg. 10000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58561 B.

Space Telegraphy.

De Forest System of Wireless Telegraphy. A. S. McLean. A brief illustrated explanation of this system and its operation. 1600 w. Yale Sci M—Oct., 1903. No. 58475 C.

Experiments on Selective Wireless Telegraphy. Anders Bull. An account of recent tests made of the author's system. 1200 w. Elect'n, Lond—Oct. 2, 1903. No. 58283 A.

The Kamm Typewriter for Use with Wireless Telegraphy. Illustrates and describes this ingenious instrument used for transmitting or receiving messages, explaining the *modus operandi*. 1800 w. Sci Am—Oct. 17, 1903. No. 58406.

The Present Status of Wireless Telegraphy (L'Etat Actuel de la Télégraphie sans Fil). C. Tissot. A general review of the fundamental principles involved in magnetic space telegraphy and a description of the detailed devices actually in use. 7000 w. Rev Gen des Sciences—Oct. 15, 1903. No. 58530 D.

The Snow Wireless Telegraph System. Dr. Louis Duncan. An account of the fundamental principles of this system. 1800 w. Elec Wld & Engr—Oct. 24, 1903. No. 58659.

The Stone Wireless Telegraph System. An illustrated article describing Mr. Stone's work in selective wireless telegraphy. 2200 w. Elec Rev, N Y—Oct. 24, 1903. No. 58623.

The Wireless Protocol. Text of the final protocol of the international wireless telegraph conference. 600 w. Sci Am Sup—Oct. 10, 1903. No. 58372.

Switchboards.

Alternating Current Switchboards. Stephen Q. Hayes. The first of a series of articles giving illustrated descriptions of boards made by the Westinghouse Company. 1600 w. Elec Wld & Engr—Sept. 26, 1903. Serial. 1st part. No. 58125.

Telegraphone.

The New Telegraphone. An illustrated description of recent improvements made in the Poulsen invention. 900 w. Sci Am—Oct. 3 1903. No. 58173.

The Telephone and the Railway. Brief account of recent tests made on a number of American railways with the telegraphone. 1000 w. Sci Am—Oct. 24, 1903. No. 58647.

Telephone Cables.

Cable Tests and Specifications. H. J. Dommerque. Discusses the electrical requirements of a telephone cable when in service, indicating methods of testing and making up specifications. 3300 w. Am Elect'n—Oct., 1903. No. 58360.

The Efficiency of Telephone Cables with Uniformly Divided Self-Induction (Ueber die Leistungsfähigkeit von Fernsprechkabeln mit Stetig Verteilter Selbstinduktion). F. Dolezalek & A. Ebeling. A theoretical and practical study of the action of the Pupin coils upon the performance of telephone lines. 5000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58560 B.

Telephony.

How the Telephone Operator Assists the Electrician. Arthur B. Weeks. A description of the work of the telephone operator and electrician on emergencies. 1800 w. St Ry Rev—Sept. 20, 1903. No. 58129 C.

Independent Telephony in Great Britain. The first of a series of articles on the construction, capital cost and managements of exchanges in England. 2000 w. Elec Engr, Lond—Oct. 2, 1903. Serial. 1st part. No. 58279 A.

Portsmouth Corporation Telephones. Explains the commercial policy of the undertaking and illustrates and describes the equipment. 2500 w. Elec Engr, Lond—Oct. 9, 1903. No. 58420 A.

Two-Wire Intercommunicating Telephone Systems. H. S. Webb. Explains what is meant by the title and describes the system, illustrating with diagrams. 1800 w. Am Elect'n—Oct., 1903. No. 58364.

DISTRIBUTION.

Booster.

A Simple Alternating Current Booster. F. B. O'Hanlon. Explains the principle on which these boosters are designed. 3500 w. Am Elect'n—Oct., 1903. No. 58359.

Current Conversion.

Continuous Currents from Alternating Supply Mains (Gleichstrom aus Wechselstromnetzen). K. Sterzel. Describing a form of apparatus for deriving a pulsating current of constant direction from an alternating circuit. The flow is equalized by a storage battery. 2500 w. Elektrotech Zeitschr—Oct. 8, 1903. No. 58566 B.

Motor Generators and Rotary Converters. H. M. Hobart. Examines the properties of these two types of apparatus, favoring the use of motor generators because of their superiority in convenience of operation. 1500 w. Elec Rev, Lond—Sept. 25, 1903. Serial. 1st part. No. 58201 A.

Lost-Current.

Lost and Unaccounted for Current. L. G. Van Ness. Classifies the losses under

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both alternating and direct systems, endeavoring to show that they may be accounted for and suggests means of reducing the loss. 2200 w. Cent Sta—Oct., 1903. No. 58314.

Mains.

Trouble Prevention on Electric Mains. J. H. C. Brooking. Considers details needing attention and gives hints of use to central station engineers. 1800 w. Feilden's Mag—Oct., 1903. No. 58472 B.

Motor-Generators.

The Motor Generator Sets of the Stockholm Electric Station (Motor Generator Gruppen des Elektrizitätswerkes Stockholm). A description of the 500 kw motor-generator converters built by the Oerlikon works with data and results of tests. 3000 w. Schweiz Bauzeitung—Oct. 3, 1903. No. 58557 B.

Resistance Switch.

Liquid Resistance Switch. Illustrated description of a new form of liquid resistance switch, which combines a circuit-breaking and direction-reversing arrangement with a regulating resistance. 800 w. Engr, Lond—Oct. 9, 1903. No. 58443 A.

ELECTRO-CHEMISTRY.

Accumulators.

Total and Free Energy of the Lead Accumulator. R. A. Lehfeldt. Read before the Faraday Soc. An analysis of the transformations of energy. 3000 w. Electro-Chem & Met—Sept., 1903. No. 58234 E.

Arsenic Detection.

The Electrolytic Estimation of Minute Quantities of Arsenic, More Especially in Brewing Materials. T. E. Thorpe. Illustrated description of apparatus and methods. 4000 w. Electro-Chem & Met—Sept., 1903. No. 58236 E.

Electrolysis.

The Present Position of the Theory of Electrolysis. W. C. Dampier-Whetham. Read before the Faraday Society. Reviews the investigations made to explain the phenomena of electrolysis, and the results thus far established. 7000 w. Elect'n, Lond—Oct. 9, 1903. No. 58424 A.

Metals.

Chemical Valency, Electrical Conductivity and Hardness of Metals. John G. A. Rhodin. A study of the conductivity of metals from an electro-chemical standpoint. 2500 w. Electro-Chem & Met—Sept., 1903. No. 58235 E.

Primary Battery.

A Simple and Economical High-Voltage Battery. Charles J. Sullivan. Illustrates and describes an outfit which requires care for only five gravity cells. 800 w. Sci Am Sup—Oct. 24, 1903. No. 58650.

ELECTRO-PHYSICS.

Electron Theory.

A Theory of Ons: In Reconciliation of the Undulatory Theory of Electricity with Ionization and the Electron Hypothesis. R. R. Bowker. Presents an hypothesis for the consideration of investigators. Also editorial. 2800 w. Elec Wld & Engr—Sept. 26, 1903. No. 58124.

Electrostatic Transformers.

On an Attempt to Construct an Electrostatic Transformer. James Edmund Ives. Describes some experiments with a ballistic galvanometer, and others with the alternating-current. 800 w. Elec Wld & Engr—Oct. 10, 1903. No. 58339.

Losses.

Iron Loss. An explanation of the great difference between the iron loss in dynamos and in transformers. 2200 w. Elect'n, Lond—Oct. 16, 1903. No. 58499 A.

Maximum Current.

A Proof of the Law for Grouping Cells to Obtain Maximum Current. E Dana Pierce. Gives an algebraic proof which is mathematically complete and capable of being understood by any one familiar with simple algebra. 500 w. Elec Wld & Engr—Oct. 3, 1903. No. 58253.

Radio-Activity.

Radio-Activity. Editorial review of the recent paper by Prof. Rutherford and Mr. Soddy, and the work of other experimenters. 2500 w. Engng—Sept. 25, 1903. No. 58209 A.

Radio-Activity. The Secret of Radium's Light and Heat. Hudson Maxim. Explains the writer's theory. 2000 w. Sci Am Sup—Oct. 3, 1903. No. 58178.

The Stereoscopic Radioscope (La Radioscopie Stéréscopique). Describing the Villard apparatus, using a Ruhmkorff coil and stroboscope for obtaining stereoscopic effects. 1800 w. Génie Civil—Oct. 3, 1903. No. 58506 D.

Speed of X-Rays Determined by M. Blondlot. C. L. Durand. Gives a method proving that the x-rays are propagated with the same velocity as those of light. 1800 w. Elec Rev, N Y—Oct. 17, 1903. No. 58452.

GENERATING STATIONS.

Armatures.

The Reaction of Alternator Armatures (Réaction d' Induit des Alternateurs). C. F. Guilbert. A study of the counter electro-motive force of the armature, using both analytical and graphical methods. Two articles. 4500 w. Revue Technique—Sept. 25, Oct. 10, 1903. No. 58507 each D.

Auxiliary Plant.

Central Station Auxiliary Plant. Fran-

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cis H. Davies. A detailed discussion of pumps, injectors, stoking and economizer gear, etc. 2300 w. Elec Rev, Lond—Sept. 25, 1903. No. 58200 A.

Dublin.

Electricity Supply in Dublin. Reviews the history of the Dublin works, explaining the backward condition of electricity supply matters, and begins an illustrated description of the new works just completed, at Pigeon House Fort. 2200 w. Elect'n, Lond—Sept. 25, 1903. Serial. 1st part. No. 58202 A.

Dynamo Design.

The Influence of Rotative Speed upon the Design of Continuous-Current Dynamos (Der Einfluss der Tourenzahl auf der Entwurf von Gleichstrommaschinen). H. M. Hobart. Considering especially the design of very high speed generators, such as are adapted to be driven by steam turbines. 5000 w. Elektrotech Zeitschr—Oct. 1, 1903. No. 58564 B.

The Modern Construction of Electric Machinery (Moderne Konstruktionen in Elektro-Maschinenbau). A. Tischbein. With especial reference to correct proportions, including the use of ball bearings. Serial, Part I. 3000 w. Glasers Annalen —Sept. 15, 1903. No. 58522 D.

Electrical Machinery.

Electric Light and Power Engineering. This first paper is a description of the construction and action of dynamos. 3700 w. Mech Engr—Oct. 10, 1903. Serial. 1st part. No. 58419 A.

Exposition Plant.

The 60,000 Horse-Power Plant at the World's Fair. Godfrey L. Carden. Information of interest in regard to the power plant and the work it is to do. 1300 w. Sci Am—Oct. 3, 1903. No. 58170.

Fitchburg.

Electrical Supply in Fitchburg. Illustrates and describes the generating station of the Fitchburg (Mass.) Gas & Electric Light Co., giving interesting features of the city as well. 2200 w. Elec Wld & Engr—Oct. 3, 1903. No. 58251.

Gas Power.

Gas-Driven Electric-Light Plant at Tunis. Illustrations with brief description of a plant in which producers' gas and gas engines furnish the motive power. 500 w. Engng—Sept. 25, 1903. No. 58206 A.

Heyland Generators.

On the Compensation and Compounding of Alternating-Current Generators. H. S. Meyer. Remarks on the generators of the Heyland type. 1500 w. Elect'n, Lond—Oct. 16, 1903. No. 58498 A.

Hydro-Electric.

Transmission of Hudson River Power. An illustrated description of the Spier Falls power development. 3000 w. Elec Wld & Engr—Oct. 24, 1903. No. 58657.

Isolated Plant.

Electrical Equipment of a Grain Elevator. C. W. Whitney. An illustrated description of the power plant of the Southern Pacific Terminal Co., at Galveston, Texas. 1500 w. Am Elect'n—Oct., 1903. No. 58358.

Electrical Equipment of an Industrial Plant. An illustrated description of the power and lighting plant of the Grand Union Tea Co., at Brooklyn, N. Y. 2500 w. Am Elect'n—Oct., 1903. No. 58361.

Mining Plant.

Polyphase Electric Plant at the Staveley Coal and Iron Company's Collieries. An illustrated detailed description of this plant recently installed in English mines. 3200 w. Ir & Coal Trds Rev—Sept. 25, 1903. No. 58218 A.

Parallel Runnning.

The Parallel Working of Alternators. B. Hopkinson. Read at Southport meeting of the British Assn. An attempt to harmonize the mathematical treatment with the practical rules regarded as good practice. 5000 w. Elec Engr, Lond—Sept. 25, 1903. No. 58197 A.

Polyphase.

Improved Compound Polyphase Generator (Neuer Compound-Drehstrom-Generator). E. Kolben. Describing a modification of the Heyland machine with especial reference to the commutator construction. 2500 w. Elektrotech Zeitschr —Oct. 8, 1903. No. 58567 B.

Synchronism.

Synchronising Devices. F. H. Davies. Describes the earliest method used, and some recent devices, commenting on their efficiency. 1800 w. Elec Engr, Lond—Oct. 2, 1903. No. 58280 A.

Vienna.

The Municipal Electric Stations in Vienna (Die Städtischen Elektrizitätswerke in Wien). Gustav Klose. A very full illustrated account of the large generating stations at Vienna furnishing current for tramways, lighting and power. Three articles. 10000 w. Zeitschr d Oesterr Ingr Arch Ver—Sept. 25, Oct. 2, 9, 1903. No. 58533 each D.

LIGHTING.

Arc Lamps.

Construction of a Direct-Current Enclosed Arc Lamp. Illustrated detailed description. 2000 w. Am Elect'n—Oct., 1903. No. 58362.

The Development of Arc Lamps. William Mayo Venable. Reviews briefly the

development of both the open arc and the enclosed arc, with remarks on the direction of future improvements. 2500 w. Elec, N Y—Sept. 30, 1903. No. 58141.

Department Store.

A Notable Example of Central Station Supply of Electric Power and Light. Describes the installation in Marshall Field & Co.'s stores, in Chicago. 2200 w. Eng Rec—Sept. 26, 1903. No. 58137.

Exposition.

The Electric Light and Power Situation in St. Louis. An illustrated article reviewing the past history and present condition of the electric light and power business and outlining the future policy. 4200 w. Elec Wld & Engr—Oct. 17, 1903. No. 58460.

Illumination.

The Illumination of the Future. E. Leavenworth Elliott. Reviews briefly the progress of artificial illumination as the basis of a forecast of future development. Thinks the most probable improvement will be the use of incandescent gas as the light radiator. 1500 w. Cent Sta—Oct., 1903. No. 58313.

Nernst Lamp.

Photometric Tests of the Nernst Lamp. From the fourth progress report of the N. E. L. A. Committee for Investigating the Photometric Values of Arc Lamps. 1500 w. Elec Wld & Engr—Oct. 24, 1903. No. 58659.

See also Civil Engineering, Municipal.

MEASUREMENT.

Ammeter.

A Graphic Recording Ammeter. A. H. Armstrong. Illustrates and describes this instrument. 1000 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 58619 D.

Armature Testing.

Armature Testing with a Milli-Voltmeter. Cale Gough. On the use of the milli-voltmeter for finding defects, the method of testing, etc. 1800 w. St Ry Jour—Oct. 3, 1903. No. 58247 C.

Conductivity.

The Conductometer. Illustrates and describes a direct reading conductivity meter devised by Rollo Appleyard. 1500 w. Elec Rev, Lond—Oct. 9, 1903. No. 58423 A.

Galvanometers.

Consideration of Some Points in the Design and Working of Ballistic Galvanometers. P. H. Powell. Read at the Southport meeting of the British Assn. Gives an illustrated outline of the design of one of these instruments. 1200 w. Elec Rev, Lond—Sept. 25, 1903. No. 58199 A.

Insulation.

A Method for Determining the Electrical Resistance of High Insulating Substances (Ein Verfahren zur Bestimmung der Elektrischen Durchschlagsfestigkeit Hochisolierender Substanzen). Dr. B. Walter. Discussing the breaking-down resistance of glass, hard rubber and similar substances, with data and results of experiments. 10000 w. Elektrotech Zeitschr—Sept. 24, 1903. No. 58562 B.

Power Measurement

The Measurement of Power in Alternating-Current Circuits. F. W. Ballard. Abstract of a lecture before the United Assn. of Sta. Engrs. of Cleveland Description of methods employed. 3300 w. Engr, U S A—Oct. 1, 1903. No. 58242 C.

Three-Phase Power Measurements. F. Hardie Jeannin. Describes a graphical method for computing the power in any three-phase system with no other data than the three ammeter and voltmeter readings. Also editorial notes. 4500 w. Elec Wld & Engr—Oct. 10, 1903. No. 58340.

Resistance.

An Improved Graphite Resistance (Ein Neuer Graphitwiderstand). R. Hopfell. The graphite is used in the form of powder compressed in cylindrical cases. 1500 w. Elektrotech Zeitschr—Oct. 8, 1903. No. 58568 B.

Rheostats.

Rheostats for Dynamo Load Tests. Brief illustrated description of how to make a simple form of water rheostat. 1000 w. Am Elect'n—Oct., 1903. No. 58363.

Standards.

Experiments for Improving the Construction of Practical Standards for Electrical Measurements. Report of a committee of the British Association, presented at Southport. 4000 w. Elect'n, Lond—Oct. 2, 1903. No. 58284 A.

Transformers.

Measuring Instrument Transformers. F. Punga. Explains the use of transformers in connection with measuring instruments to measure currents, showing the influence of various factors on the ratio of primary to secondary currents. Ill. 2500 w. Elect'n, Lond—Oct. 9, 1903. No. 58425 A.

POWER APPLICATIONS.

Air Compressors.

Electrically Driven Air Compressors (Elektrisch Betriebene Luftkompressoren). A fully illustrated account of the application of electric driving to various forms of air compressors, with especial reference to their use in mining work. Two articles. 1 plate. 4000 w. Glückauf —Oct. 3, 10, 1903. No. 58549 each D.

We supply copies of these articles. See page 479.

Department Store.

See Electrical Engineering, Lighting.

Electrical Energy.

On the Mechanism of Electric Power Transmission. Dr. A. E. Kennelly. Considers Hertzian as well as alternating and direct-current transmission, illustrating by example the application of the principles. 2500 w. Elec Wld & Engr—Oct. 24, 1903. No. 58658.

Elevators.

The Arrangement of Controllers for Electric Elevators (Die Elemente des Druckknopfsteuerungen für Elektrische Aufzüge). Dr. K. Kahle. Discussing especially the connections for controlling electric elevators by means of push buttons on the various floors. 7000 w. Elektrotech Zeitschr—Sept. 17, 1903. No. 58558 B.

Factories.

Purchased Electric Power in Factories. E. W. Lloyd. Abstract of a paper read before the Assn. of Edison Ill. Cos. Considers the installation of motors, and the cost of power from central stations for large factories, as compared with isolated plant costs. 3200 w. Elec Wld & Engr—Sept. 26, 1903. No. 58127.

Induction Motors.

Management of Induction Motors. George T. Hanchett. Describes the behavior of the induction motor, and shows why it is often objectionable. 2500 w. Cent Sta—Oct., 1903. No. 58312.

Repulsion Motors.

On Single-Phase Repulsion Motors. William Cramp. Read at Southport meeting of the British Assn. A study of the design of the repulsion motor. Ill. 4000 w. Elec Engr, Lond—Sept. 25, 1903. Serial. 1st part. No. 58198 A.

Speed Variation.

A Possible Source for Securing Wide Speed Range in Direct-Current Motors. Albert F. Hemingway. Describes methods that have been tried, especially the design of E. Lanhoffe, and the type conceived by the author. 2400 w. Elec Wld & Engr—Oct. 3, 1903. No. 58254.

Starters.

Graphical Proportioning of Starters (Zeichnerische Bestimmung von Anlassern). Rudolf Krause. Deriving diagrams for use in designing starters for motors of various types and speeds. 1500 w. Zeitschr f Elektrotechnik—Oct. 4, 1903. No. 58570 D.

TRANSMISSION.

Arresters.

Lightning Arresters on Transmission Lines. Alton D. Adams. Considers the dangers from atmospheric electricity, the true purpose of lightning arresters, the types in use, the most recent practice, the degree of security, etc. 4500 w. Elec Rev, N. Y.—Oct. 10, 1903. No. 58337.

Circuit Breakers.

Reverse Current Circuit Breakers and the Protection of Transmission Lines. Leonard Wilson. Considers this system of protection, discussing its more important characteristics, and the essential feature of the Andrews system. 2200 w. Trans Am Inst of Elec Engrs—June, 1903. No. 58618 D.

Line.

Overhead Pole Line Construction and Operation for Central Stations. A. H. Manwaring and J. T. Hutchings. Read at meeting of the Assn. of Edison Ill. Co.'s. Treats of important points to be considered in successful pole line construction for a plant supplying current for series arc lighting and alternating current for light and power. 4000 w. Elec Wld & Engr—Sept. 26, 1903. No. 58126.

Mining Transmission.

Relative Advantage of 2,300-Volt Alternating Current versus 550-Volt Direct Current, for Mine and Smelter Work. Hugh A. Brown. States the advantages of each. 1500 w. Eng & Min Jour—Sept. 26, 1903. No. 58135.

Protection.

Protective Devices for High-Tension Electrical Systems. W. B. Woodhouse. Read before the British Assn. An illustrated article discussing points in connection with the operation of a high-tension polyphase transmission system. 2800 w. Elect'n, Lond—Sept. 25, 1903. No. 58-203 A.

Three-Phase.

On Three-Phase Switch Gear. A. C. Eborall. An illustrated article, giving the writer's reasons for not favoring the cellular and backless type of switchboard in connection with high-pressure symptoms, aud outlining the lines upon which such switchboards should be constructed. 5500 w. Engng—Sept. 25, 1903. Serial. 1st part. No. 58205 A.

The First Transmission of Energy in Europe by Means of Triphase Currents. Emile Guarini. Illustrated description of the Hochfeld-Glattfeld-Oerlikon line. 2000 w. Sci Am Sup—Oct. 17, 1903. No. 58411.

Wire Stresses.

Computation of Sag and Stress in Freely Suspended Wires (Berechnung des Durchhanges und der Spannung in Frei Gespannten Drähten). A. Sengel. Developing equations for the determination of the catenary for overhead wires. 2500 w. Elektrotech Zeitschr—Sept. 24, 1903. No. 58563 B.

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GAS WORKS ENGINEERING

Acetylene.

The Generation of Acetylene. J. M. Morehead. Considers the points of danger, and claims that the generators now used, if operated according to instruction, are safe. 2700 w. Elec-Chem Ind—Oct., 1903. No. 58322 C.

Cannel Coal.

Boghead Cannel. A copy of a report of this coal made in 1850 in regard to its value for the production of gas. 1500 w. Gas Wld—Oct. 17, 1903. No. 58490 A.

Coal Tar.

The Distillation of Coal Tar. Harold Smith. Read before the Manchester & Dist. Jr. Gas Assn. A description of the process involved in the extraction of the crude products, mentioning their principal uses. Discussion. 3600 w. Jour Gas Lgt—Sept. 29, 1903. No. 58270 A.

Gas Works.

Steel Building Construction in Gas-Works. Samuel Cutler, Jr. Read before the Eastern Co.'s Gas Mgrs.' Assn. An illustrated article considering particularly buildings for inclined retort-benches and carburetted water-gas plants, giving brief descriptions of examples. General discussion. 8000 w. Jour Gas Lgt—Sept. 22, 1903. No. 58194 A.

Inclined Retorts.

The Home of the Inclined Retort in England. An illustrated article describing the past and present systems of the Brentford Gas Co. at Southall, England. 4000 w. Jour Gas Lgt—Sept. 29, 1903. No. 58269 A.

Lighthouses.

Acetylene Gas in the Chassiron Lighthouse. An illustrated description of experiments being carried out in France which greatly increase the illuminating power. 1800 w. Engng—Oct. 16, 1903. No. 58476 A.

Use of the Incandescent Mantle in Lighthouses. Illustrates and describes the incandescent arrangements in use in France. 1000 w. Sci Am Sup—Oct. 17, 1903. No. 58412.

Mantles.

The Action of the Incandescent Mantle in the Flame. Epitome of a long communication by Dr. C. Killing, to a recent number of the *Journal für Gasbeleuchtung*, on the theoretical basis of incandescent gas lighting. 1400 w. Jour of Gas Lgt—Oct. 13, 1903. No. 58493 A.

Photometer.

A Development of the Simmance-Abady "Flicker" Photometer. Illustrates and describes a modification presenting a wider range of utility than the original form. 1500 w. Jour Gas Lgt—Oct. 6, 1903. No. 58378 A.

Purification.

A Simplified Method of Gas Purification to Completely Recover Tar and Ammonia. Abstract translation of a short paper by Herr Burgemeister at the meeting of the German Assn. of Gas & Water Engrs. Ill. 1300 w. Jour of Gas Lgt—Oct. 13, 1903. No. 58492 A.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

Tynemouth.

Constructional Details and Costs of Recent Extensions (1900-1902), with Notes on Working Results, at the Tynemouth Gas-Works, North Shields. A. Clement Hovey. Read before the North of Eng. Gas Mgrs.' Assn. Ill. 12500 w. Jour Gas Lgt—Oct. 6, 1903. No. 58380 A.

See also Civil Engineering; Municipal.

INDUSTRIAL ECONOMY

Apprentices.

Engineering Apprentices. D. B. Morison. Outlines a scheme for the advancement of apprentices to be given a trial at the Hartlepool Engine Works. Also editorial. 2400 w. Engng—Sept. 25, 1903. No. 58208 A.

The Apprenticeship Question. John E. Sweet. Read before the Mutual Trades Assn. of Syracuse, N. Y. Remarks on the changed conditions and the necessity of providing proper instruction for American boys who wish to become mechanics, suggesting ways. 2800 w. Am Mach—Oct. 22, 1903. No. 58615.

Coal Syndicate.

The Reconstruction of the Westphalian Coal Syndicate. Discusses the project for the reconstruction and the chief points of the new agreement. 2200 w. Ir & Coal Trds Rev—Oct. 9, 1903. No. 58429 A.

Education.

Commercial and Industrial Education in England. Discusses the neglect of commercial and technical training until

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recently, and what is now being done. 2500 w. U S Cons Repts. No 1786—Oct 28, 1903. No. 58631 D.

English Industry and Advanced Technical Education. Prof. H. I. Hannover. Extract from paper read before the Danish Inst. of Engrs. Impressions from a visit to English factories and colleges. 8000 w. Engng—Oct. 16, 1903. No. 58480 A.

Functions of Technical Science in Education for Business and the Professions. Robert H. Thurston. An address at the dedication of Engng. Hall, Iowa State College. 8000 w. Sci Am Sup—Oct. 24, 31, 1903. Serial. 2 parts. No. 58651.

Report upon Engineering Education. Elmer L. Corthell. A digest of information gathered during an extended tour, and years of study, giving present methods of teaching engineering in various countries, and comparing with similiar schools in the United States, with recommendations. 23800 w. Tech Qr—Sept., 1903. No. 58384 E.

Technical Education, What it Should be. Dr. Louis Duncan. A discussion of the relation of technical education to commercial and industrial progress. Also editorial comment. 3000 w. Engineering Magazine—Nov., 1903. No. 58581 B.

Erie Canal.

See Civil Engineering, Canals, Rivers and Harbors.

Exposition.

Some of the Engineering Features of the Louisiana Purchase Exposition, St. Louis, 1904. An illustrated article, giving general topographic plan of the grounds. The present number explains the character of the exposition, the civil engineering methods, river improvement, transportation, &c. 3000 w. Eng Rec—Oct. 3, 1903. Serial. 1st part. No. 58262.

Labor.

The Attitude of Trades Unions Toward Trade Schools. William H. Sayward. Why they do not look with favor on these schools, with a consideration of trade school conditions in various countries. 4000 w. Am Gas Lgt Jour—Oct. 12, 1903. No. 58321.

Steel Trade.

The United States Steel Corporation and the Outlook for the Steel Trade. Briefly reviews the development of the trust movement, methods, formation, &c., the danger that beset the U. S. Steel Corporation, and considerations favoring the combination. 4000 w. Ir & Coal Trds Rev—Oct. 2, 1903. No. 58308 A.

Works Management.

The Ethics of Workshop Management. Egbert P. Watson. A discussion of actual working relations between employers and men in the shop, based on extended experience. 2000 w. Engineering Magazine—Nov., 1903. No. 58587 B.

MARINE AND NAVAL ENGINEERING

Battleships.

The Latest Battleships for the United States Navy. Illustration, with brief description of the design of the "Louisiana" class. 900 w. Sci Am—Oct. 17, 1903. No. 58407.

Cruiser.

Some New Warships. Illustrated descriptions of the Hampshire, a cruiser of the Devonshire class, and the new Turkish cruiser "Abdul Hamid." Also briefly notices other vessels. 900 w. Engr, Lond—Oct. 2, 1903. No. 58301 A.

Cunard Contract.

The New Cunard Steamship Contract. Eugene Tyler Chamberlain. Considers this contract, and the agreement of the British Government with the International Marine Assn., and the effect on the future of American shipping. 4500 w. N Am Rev—Oct., 1903. No. 58287 D.

Ferryboats.

San Francisco Bay Ferryboats, San Jose and Yerba Buena. Illustrates and describes new boats of the double-screw type. 900 w. Naut Gaz—Oct. 15, 1903. No 58383.

San Francisco Bay Ferryboats, San Jose and Yerba Buena. Illustrates and describes the machinery of these boats designed for fast service. 2000 w. Naut Gaz—Oct. 22, 1903. No. 58608.

Japan

The Growing Naval Power of Japan. Archibald S. Hurd. An interesting account of the development of the navy, and the people who control the vessels. 3300 w. N Am Rev—Oct., 1903. No. 58288 D.

Launches.

Power Launches. An illustrated article giving general information of the material used, the construction, dimensions, &c. 2500 w. Naut Gaz—Sept. 24, 1903. No 58115.

Lubrication.

Internal Lubrication of Marine Machinery. H. C. Duryea. Considers remedies to secure as nearly as possible, the

desired conditions. 2000 w. Marine Engng—Oct., 1903. No. 58143 C.

Mold Work.

Practical Mold Work in Shipyards. Sidney H. McLane. On the advantages of mold work, illustrating by example. 1500 w. Marine Engng—Oct., 1903. No. 58146 C.

Old Navy.

Ships of the Old Navy. Illustrates types of naval construction prevailing during the first three-quarters of the past century, giving a summary of their careers. 2000 w. Marine Engng—Oct., 1903. No. 58144 C.

Rivet Spacing.

Rivet Spacing in Merchant Vessels Classed at Lloyds. Gives a classification based on the best practice. 1200 w. Fielden's Mag—Oct., 1903. No. 58473 B.

Salvage.

Salvage of the German Steamer Muenchen. Translated from *Marine Rund-Schau.* An account of the grounding of a steamer on one of the Caroline Islands and the work of salvage under trying conditions. Ill. 3300 w. Naut Gaz—Oct. 8, 1903. No. 58310.

Steamships.

New Steamer Asbury Park, for the New York-Sandy Hook Route. An illustrated detailed description of this steamer and its equipment. 2200 w. Marine Engng—Oct., 1903. No. 58142 C.

Steamship Carpathia. Illustrates and describes this new vessel of the Cunard Line. 1000 w. Marine Engng—Oct., 1903. No. 58145 C.

The Steamship Kaiser Wilhelm II. (Le Paquebot Kaiser Wilhelm II. J. Bousquet.) A general illustrated description of the German transatlantic steamship, showing the construction and interior finishing. Serial. Part I. 3000 w. Génie Civil—Oct. 3, 1903. No. 58504 D.

Workshop.

A Floating Workshop. Illustrations, with brief description of a vessel recently completed for Durban Harbor. 500 w. Engr, Lond—Sept. 25, 1903. No. 58212 A.

MECHANICAL ENGINEERING

Construction.

Automobile Construction. Hugh Dolnar. The first article is introductory to a series describing methods and construction routine. 700 w. Am Mach—Oct. 8, 1903. No. 58390.

Developments in Automobile Construction. T. Clarkson. Especially considers vehicles weighing from half a ton to two tons, the working conditions of commercial automobilism, &c. 3000 w. Engr, Lond—Sept. 25, 1903. Serial. 1st part. No. 58217 A.

Electric Truck.

Coal Delivery in New York by an Electric Truck. Illustrates a vehicle in use in New York and vicinity, describing its working. 1000 w. Automobile—Oct. 10, 1903. No. 58320.

Gasoline Cabs.

London's Gasoline-Propelled Cabs. Illustration with brief description. 600 w. Sci Am—Oct. 3, 1903. No. 58172.

Gasoline Motor.

The Latest Applications of the Gasoline Automobile Motor. Illustrates its application to a railway inspection car, and also to a light delivery wagon. 500 w. Sci Am—Oct. 17, 1903. No. 58410.

Ignition.

A Simplification in Electric Ignition. Illustrated description of the system of high-tension ignition designed by Mr. Budge. 800 w. Autocar—Oct. 10, 1903. No. 58416 A.

Lamps.

Automobile Lamps. Illustrations of 20 styles, with brief descriptions. 3000 w. Automobile—Sept. 26, 1903. No. 58163.

Legislation.

British Motor-Car Act. Abstracts of an editorial in the Birmingham *Daily Post*, giving an idea of the scope and intentions of the act. 1500 w. U S Cons Repts, No. 1774—Oct. 14, 1903. No. 58366 D.

Lurries.

The Thornycroft Self-Propelled Lurries. Illustrates and describes a lurry driven by an internal combustion engine using petroleum. Also record of mileage. 1200 w. Auto Jour—Oct 17, 1903. No. 58601 A.

Mixed System.

A New Type of Gasoline-Electric Automobiles with Hub Motors. Illustrated description of new vehicles of the Lohner-Porsche firm. 1800 w. Sci Am Sup—Oct. 24, 1903. No. 58653.

Petrol-Electric Automobiles—The Mixed System. J. Sutherland Warner. The present article describes the advantages and disadvantages of the petrol car and also of the electric vehicle, as introductory to a description of a combined system. 1800 w. Elec Times—Oct. 1, 1903. Serial. 1st part. No. 58271 A.

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Motor Bicycle.

The Starley Motor Bicycle. An illustrated description of a motor bicycle having many interesting features. 1800 w. Auto Jour—Oct. 10, 1903. No. 58417 A.

Motor Transport.

Motor Transport for Goods. Douglas Mackenzie. A report of the present condition of this field in England. 3800 w. Prac Engr—Oct. 16, 1903. Serial. 1st part. No. 58494 A.

Motor Vehicles.

Mechanical Road Vehicles. W. Worby Beaumont. A review of the achievements in this field, especially since 1896. 6400 w. Jour Soc of Arts—Oct. 16, 1903. Serial. Part I. No. 58654.

Motor Wagons.

Automobiles for Industrial Service (Motorfahrzenge für Nutzzwecke). Illustrated descriptions of Daimler vehicles for conveying merchandise, also description of the Daimler military wagon constructed for the German army. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 19, 1903. No. 58512 D.

Petrol Cars.

The Cadillac Petrol Car. Begins an illustrated detailed description of a car of moderate power and cost. 1300 w. Auto Jour—Oct. 17, 1903. Serial. 1st part. No. 58600 A.

Review.

Automobilism in 1903 (L' Automobilisme en 1903.) Gérard Lavergne. A review of automobile affairs in France during the current year, including the meetings, exhibitions, etc., and an account of improvements in details of vehicle and motor construction. 4000 w. Rev Gen des Sciences—Sept. 30, 1903. No. 58529 D.

Road Locomotive.

An Early Road Locomotive. Illustration, with historical account and description of a machine made about 1784. 1200 w. Sci Am—Oct. 17, 1903. No. 58409.

Steam Vehicles.

Steam Waggons for Commercial Use. R. G. L. Markham. A discussion of present practice, and use of these vehicles, especially considering those made in Great Britain. 3300 w. Cassier's Mag—Oct., 1903. No. 58691 B.

Traction.

The Resistance of Road Vehicles to Traction. Report of a committee submitted to the British Assn. Gives results of trials, suggestions, abstracts of papers, &c. 5800 w. Engng—Sept. 25, 1903. No. 58211 A.

Trials.

The Motor Car Trials. A review of the cost of these trials, giving particulars. 1700 w. Engr, Lond—Oct. 2, 1903. No 58304 A.

The Motor Car Trials. Review of the recent 1000 miles reliability trials organized by the British Automobile Club. 3000 w. Engr, Lond—Sept. 25, 1903. No. 58213 A.

The 1903 Reliability Trials from a Technical Point of View. Considers the present state of the automobile industry, and compares the merits of the different cars. Deals first with the petrol engines, showing how they compare for size and output. 2000 w. Auto Jour—Oct. 10, 1903. Serial. 1st part. No. 58418 A.

Tyres.

Tyres in the 1,000 Miles Trials. Gives details of their behavior, as furnished by the competitors. Ill. 1800 w. Autocar—Oct. 17, 1903. No. 38603 A.

Voiturette.

The 5-H.-P. Cottereau Voiturette. An illustrated detailed description. 1200 w. Auto Jour—Oct. 3, 1903. Serial. 1st part. No. 58275 A.

HYDRAULICS.

Hoist.

Hydraulic Coal Hoist at Glasgow Harbor. Illustration of the hoist and its approaches with information as to its construction. 1000 w. Engr, Lond—Oct. 16, 1903. No. 58486 A.

Hydraulic Machinery.

Diagrams for Estimating Hydraulic Machinery. Frank B. Kleinhaus. Gives diagrams with explanatory notes. 500 w. Eng. News—Oct. 22, 1903. No. 58635.

Pumps.

Riedler High-Speed Pumps (Riedler Expresspumpen.) H. Lehmann. Describing pumps recently installed at the Engelsburg mine near Bochum. The pumps run at 150 revolutions per minute and deliver 3.72 cubic metres per second against a head of 580 metres. 2000 w. Zeitsher d Ver Deutscher Ing—Sept. 19, 1903. No. 58515 D.

Safety Devices.

The Hydraulic Safety Devices of the Public Records Building at The Hague (De Hydraulische Veiligheidsinrichtingen van het Algemeen Rijks-Archiefgebouw te s'Gravenhage). W. Schlusen. Describing the complete system by which all doors, windows and other openings may be immediately closed by hydraulic power, providing protection against fire and burglary. 2500 w. De Ingenieur—Sept. 19, 1903. No. 58575 D.

Turbines.

A Comparison Between Axial Turbines and the Modern Radial Turbines (Verg-

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leich zwischen Achsial turbinen und den Neueren Radialturbinen.) Prof. Pfarr. A discussion of the advantages of the Francis type of turbine over the older Jonval design, showing the reasons for the higher efficiency of the former. 2000 w. Zeitscher d Ver Deutscher Ing—Sept. 26, 1903. No. 58516 D.

Valves.

Stratton's Four-Way Hydraulic Valve. Illustrates and describes an ingenious device. 1200 w. Engng—Oct. 9, 1903. No. 58433 A.

Water-Powers.

Water Powers in the South. An illustrated article on the recent development, with especial reference to those of northern Georgia in the neighborhood of Gainesville and Dahlonega. 2500 w. Mines & Min—Oct. 1903. No. 58149 C.

See also Mechanical Engineering, Measurement.

MACHINE WORKS AND FOUNDRIES.

Apprentices.

See Industrial Economy.

Boring Machines.

Horizontal Boring Machines. Thomas R. Shaw. Gives a classification of these machines and begins an illustrated description of types of each class. 2000 w. Mech Engr—Oct. 3, 1903. Serial. 1st part. No. 58277 A.

Bridge Plant.

The Pennsylvania Steel Company's Model Bridge Plant. Part first gives an illustrated description of the general arrangement and principal features of the plant near Harrisburg, Pa. 5700 w. Eng Rec—Sept. 26, 1903. Serial. 1st part. No. 58136.

Castings.

Composition and Resistance of Steam Cylinder Castings (Zusammensetzung und Festigkeitseigenschaften des Dampfzylindergusses). F. Wüst & P. Goerens. With curves showing the strength and deflection of cast iron of various compositions. 2500 w. 1 plate. Stahl u Eisen—Oct. 1, 1903. No. 58539 D.

Steel Castings. Arthur Simonson. Considers the importance of design, and the construction of the pattern; and also more than all else, the quality of the steel. 1600 w. Foundry—Oct., 1903. No. 58231.

Chilled Iron.

Chilled Machine Tool Ways. Henry Hess. An illustrated article describing improvements due to the introduction of partially chilled guide surfaces and other applications. 1000 w. Am Mach—Oct. 8, 1903. No. 58327.

Cores.

A Responsible Job for the Coremaker. R. H. Palmer. Illustrates and describes the making of a difficult core. 1000 w. Am Mach—Oct. 15, 1903. No. 58393.

Crane Brakes.

Mechanical Crane Brakes. G. F. Dodge. Illustrations with description of a modified Western brake, in which the shell remains stationary. 1000 w. Am Mach—Oct. 29, 1903. No. 58672.

Crane Hook.

150-ton Crane Hook With Conical Roller Bearing. Ulrich Peters. Brief illustrated description. 200 w. Am Mach—Oct. 29, 1903. No. 58670.

Cranes.

See Electrical Engineering, Power Applications.

See Civil Engineering, Harbors.

Cutting Machines.

Machine for Cutting Circumferential Grooves in Steel Rolls—A Simple Chain Riveter. Brief illustrated descriptions of these machines. 800 w. Am Mach—Oct. 8, 1903. No. 58329.

Defects.

Machinery Defects and Their Causes. A review of the report of Mr. Michael Longridge, on engine, boiler, and motor breakdowns for the previous twelve months. 1800 w. Engng—Oct. 9, 1903. No. 58435 A.

Dies.

A Cutting, Bending and Forming Die. R. Lewis. Illustrated description of the die and its operation. 800 w. Am Mach—Oct. 15, 1903. No. 58394.

Automatic Slide Die for Piercing, Blanking and Drawing in One Operation. Joseph V. Woodworth. Illustrates and describes tools of improved design. 800 w. Am Mach—Oct. 22, 1903. No. 58616.

Compound Dies for Parts of Telephone Transmitter Cases. Joseph V. Woodworth. Illustrates and describes dies used in producing these parts. 2000 w. Ir Trd Rev—Oct. 1, 1903. No. 58224.

Electric Power.

See Electrical Engineering, Power Applications.

Eye-Bars.

The Making of 18-inch Steel Eye-bars. William R. Webster. A brief review of recent advances made in the annealing of eye-bars. 1000 w. Eng. News—Oct. 8, 1903. No. 58355.

The Method of Manufacturing the Large Eye-bars for the Thebes Bridge. P. S. Hildreth. Describes the making of the largest eye-bars used in bridge con-

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struction to date. 1200 w. Eng News—Oct. 8, 1903. No. 58356.

Filing.

A Foot-Power Filing Machine. Warren E. Willis. Illustrated description of a machine designed for use in die-making. 800 w. Am Mach—Oct. 29, 1903. No. 58668.

Foundry.

The Equipment of the Foundry. Joseph Horner. An illustrated article discussing especially the general shop, with departments for special work. 5500 w. Cassier's Mag.—Oct., 1903. No. 58690 B.

The Sturtevant Foundry. Illustrated description of the new foundry and pattern shop at Hyde Park, Mass. 2800 w. Ir Age—Oct. 29, 1903. No. 58667.

German Works.

Borsig's Works. Historical review and illustrated detailed description of these extensive works for the manufacture of boilers, locomotives, stationary engines operated by steam and gas, pumps, hydraulic presses, refrigerating appliances, &c. 4800 w. Engng—Oct. 9, 1903. Serial. 1st part. No. 58431 A.

Grinding.

Modern Cylindrical Grinding. C. H. Norton. Read before the Cincinnati Metal Trds. Assn. Reviews the development of grinding, the conditions of modern ground work, preparation, &c. 4000 w. Ir Trd Rev—Oct. 15, 1903. No. 58389

Heat Gauge.

The Heat Gauge in Twist Drill Work. Illustrated description of the device patented by Everett F. Morse, with information relating to the class of work to which it has been successfully applied. 1800 w. Ir Trd Rev—Oct. 1, 1903. No. 58225.

Hoisting.

Recent Hoisting Devices for Workshops (Neuere Ausführungen von Hebezeugen für Hüttenwerke). Illustrating and describing electric cranes, conveyors, charging machines, etc. Serial. Part I. 2500 w. Stahl u Eisen—Oct. 1, 1903. No. 58538 D.

Iron Works.

The La Belle Iron Works. An illustrated description of the improved works at Steubenville, Ohio. 3500 w. Ir Age—Oct. 8, 1903. No. 58264.

Jigs.

A Set of Jigs for Milling and Drilling. Joseph V. Woodworth. Illustrates and describes these tools. 1000 w. Am Mach—Oct. 8, 1903. No. 58330.

Machine Construction.

Recent Progress in Machine Construction (Neuere Fortschritte im Maschinenbau.) Hugo Seidler. A rapid review of the latest improvements in prime movers, including steam engines, hydraulic motors, and gas engines. Two articles. 6000 w. Zeitschr f Elektrotechnik—Sept. 20, 27, 1903. No. 58569 each D.

Metal Working.

The Modern Craft of Metal Working. Day Allen Willey. Brief illustrated description of methods of fashioning bronze, iron and other metals into ornamental work. 1000 w. Sci Am Sup—Oct. 3, 1903. No. 58177.

Milling Machine.

Constant Belt Speed Milling Machine. Illustrates and describes modifications in design to overcome the defects of the cone pulley as a means of driving the spindle, and of a variable spindle speed as a source from which to take the feed motion. 1500 w. Am Mach—Oct. 22, 1903. No. 58614.

Molding.

Floor Molding Without Patterns. Henry Hess. An illustrated description of improvements introduced in a foundry in Berlin, Germany. 1800 w. Foundry—Oct., 1903. No. 58230.

Instruction in Molding and Cupola Work. Thomas D. West. Part first is introductory, considering the branches of iron founding. 1000 w. Jour Am Found Assn—Oct., 1903. Serial. 1st part. No. 58689 H.

Lifting Pockets with Cores Instead of Grids or Bars. R. H. Palmer. Illustrates and describes methods used in molding. 1400 w. Am Mach—Oct. 29, 1903. No. 58673.

Molding a Thin Building Column. R. H. Palmer. Illustrated article describing the work. 1200 w. Am Mach—Oct. 1, 1903. No. 58160.

Piece Work.

The Fixing of Piece Work Rates. Hugo Diemer. Details of experience in the accurate fixing of piece work rates and the determination of speed records. 3000 w. Engineering Magazine—Nov., 1903. No 58582 B.

Punching.

The Hundhausen Ratchet System (Encliquetage Hundhausen). O. Arendt. Describing a combination of cams and ratchets applied to the feeding of dynamo discs under the punching press. Two articles. 4000 w. L'Electricien—Sept. 19, 26, 1903. No. 58576 each B.

Shaping Machine.

The Bauer Propeller-Blade Shaping Machine. An illustrated description of an important improvement for cutting or shaping the blades of ships' propellers. 1800 w. Engng—Oct. 9, 1903. No. 58434 A.

Speed Changing.

Automatic Lathe Speed Changing.

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Howard A. Coombs. Illustrates and describes various arrangements of speed-changing devices, with remarks on their use. 1600 w. Am Mach—Oct. 15, 1903. No. 58392.

Speeds.

Speeds and Feeds. Frederick Holz. Read at meeting of the Cincinnati Metal Trds. Assn. An account of experimental work, and report of work accomplished. Ill. 2200 w. Ir Trd Rev—Oct. 8, 1903. No. 58323.

Steel Mills.

New Steel Plant and Merchant Bar Mills of the International Harvester Co., at South Chicago, Ill. Illustrated detailed description. 4400 w. Ir Trd Rev—Oct. 15, 1903. No. 58388.

Tools.

A New Drill and a Cam Miller. Illustrations, with brief descriptions. 4000 w. Engr, Lond—Sept. 25, 1903. No. 58215 A.

A Tool Room System. Describes a system in operation in one of the large works in the United States. 1800 w. Am Mach—Oct. 15, 1903. No. 58391.

Tests on Finishing and Annealing Heats F. C. Lau. From *Sparks from the Anvil.* Illustrated account of experiments conducted along the regular line of shop practice, with deductions. 1000 w. Metallographist—Oct., 1903. No. 58688 F.

Tube Works.

Universal Tube Works. Illustrates and describes these works situated at Chesterfield, Eng. 1200 w. Engng—Oct. 9, 1903. No. 58432 A.

Workbenches.

Westinghouse Workbenches. John Randol. Illustrations, with brief description. 1100 w. Am. Mach—Oct. 1, 1903. No 58159.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Carborundum.

Manufacture and Uses of Carborundum. A. J. Fitz Gerald. Read before the Phila. Found. Assn. Deals with the origin of carborundum, present methods of manufacture, uses, characteristics, etc. 4000 w. Ir Age—Oct. 15, 1903. No. 58357.

Cast-Iron.

A Suggestion for a Test of the Effect of Silicon in Neutralizing Sulphur in Cast Iron. J. E. Johnson, Jr. Suggests a cheap and simple method to be carried out at the foundry. 800 w. Am Mach—Oct. 29, 1903. No. 58671.

The Chemistry and Physics of Cast Iron in the Light of Recent Knowledge. J. E. Johnson, Jr. A review of the advance made during the last three years, mentioning some important articles dealing with this subject which have appeared. 2200 w. Am Mach—Oct. 8, 1903. Serial. 1st part. No. 58328.

Manganese Steel.

The Properties and Constitution of Manganese Steel (Sur les Proprietés et la Constitution des Aciers au Manganese). Léon Guillet. A communication to the French Academy, giving the results of micrographic and mechanical investigations. 1000 w. Comptes Rendus—Sept. 21, 1903. No. 58521 D.

Microstructure.

Notes on the Microstructure of Steel. James E. Howard. Reviews the history of microscopic investigations and points emphasized by different investigators, concluding that the microscope may not yet be relied upon for the accurate determination of physical properties. 2800 w. Ir Age—Oct. 29, 1903. No. 58666.

Nickel Steel.

The Metallography of Nickel Steel. Léon Guillet. Translated from the *Bulletin de la Société d'Encouragement.* A study of the microstructure of various steels containing nickel from zero to 30 per cent. Ill. 6000 w. Metallographist—Oct., 1903. No. 58687 F.

Wire Rope.

High Grade Wire Rope. L. C. Moore. Considers the properties of standard cast steel, extra strong, and plow steel rope. 1800 w. Engrs' Soc of W Penn—Sept. 1903. No. 58446 D.

MEASUREMENT.

Depthometer.

Depthometer. Describes a recently patented instrument designed to show the depth of liquids either in open or closed vessels under any degree of pressure. 800 w. U S Cons Repts, No. 1772—Oct. 12, 1903. No. 58293 D.

Elastic Limit.

The Measurement of the Elastic Limit of Metals (Mesure de la Limite Elastique des Metaux). Ch. Frémont. Discussing the microscopic method of determining the true elastic limit at which the molecular structure of the material is changed under stress. 7000 w. Bull Soc d'Encour—Sept., 1903. No. 58526 G.

Gauges.

Micrometer Gages. A. L. Monrad. Illustrates and describes convenient tools. 1000 w. Am Mach—Oct. 29, 1903. No. 58674.

Shop Methods of Measurement and the Manufacture of Interchangeable Parts (Das Messen in der Werkstatt und die Herstellung Austauschbarer Teile). G.

Schlesinger. A discussion of the use of limit gauges in connection with automatic machine tools for the production of interchangeable machine parts. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, Oct. 3, 1903. No. 58513 each D.

Metric System.

The Adoption of the Metric System in the United States (Adoption du Système Métrique aux Etats-Unis). Responses by the Society of Civil Engineers of France to a series of questions concerning the metric system put by the American Chamber of Commerce in Paris. 7500 w. Mem Soc Ing Civ de France—Aug., 1903. No. 58571 G.

The Metric System. The objections answered by the French Society of Civil Engineers. Extracts from this discussion. 2000 w. Ir Age—Oct. 8, 1903. No. 58265.

Section Moments.

A Study of Section Moments (Studie über Querschnitts Momente). Dr. Ludwig Hess. Developing equations for the determination of centrifugal moments and moments of inertia for structural shapes of various cross sections. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 2, 1903. No. 58534 D.

Temperature.

The Morse Thermo Gauge. Illustrated description of an apparatus for gauging the temperature to which steel is heated in the process of hardening or annealing. 500 w. Am Mach—Oct. 29, 1903. No. 58669.

Underflow.

Measurements of the Underflow at the Narrows of the Rio Hondo and San Gabriel River, California. Charles S. Slichter. Describes measurements made by the electrical method of the writer. 1800 w. Eng Rec—Oct. 17, 1903. No. 58467.

POWER AND TRANSMISSION

Compressed Air.

Compressed Air Equipment at Bradford Corporation Tramways, Car Shed and Workshops. An illustrated detailed description of the uses to which compressed air is put. 1700 w. Tram & Ry Wld—Oct. 8, 1903. No. 58426 B.

The Development of the Straight Line Air Compressor. R. S. Carter. Three illustrations, with descriptions, of types showing the periods of development, and the history of the machines. 900 w. Com pressed Air—Oct., 1903. No. 58249.

See Electrical Engineering, Power Applications.

Conveyors.

Automatic Coal Conveyors for Boiler-Houses. Illustrated detailed description of the conveyors of the Central Electric Supply Company, London. 1200 w. Engr, Lond—Oct. 9, 1903. No. 58444 A.

New Rock-Handling Machinery. Alexander Forsyth. Illustrates and describes the skips, cars, and conveyors forming a part of the present system which has proved a success for the Portland Gold Mining Co. 1800 w. Eng & Min Jour—Oct. 3, 1903. No. 58256.

Wrightson's Patent Coal Shipper. Illustrates and describes an apparatus that claims minimum breakage of the coal. 900 w. Col Guard—Oct. 16, 1903. No. 58-481 A.

Lumber.

The Transportation of Lumber. Waldon Fawcett. Illustrates and describes some of the improved methods in use 1800 w. Sci Am—Oct. 17, 1903. No. 58408.

Power Distribution.

The Distribution of Power for the Operation of Harbor Cranes (Mode de Transport et de Distribution de Force pour la Commande des Grues de Port). B. Lambert. A comparative study of the relative merits of hydraulic and electric power for harbor cranes. 8000 w. Revue de Mécanique—Sept., 1903. No. 58528 E + F.

Power Measurement.

See Electrical Engineering, Measurement.

Sheaves.

Design of Sheaves and Drums for Wire Rope. Samuel Diescher. Discusses some points affecting the strength and life of the rope. 3000 w. Engrs' Soc of W Penn —Sept., 1903. No. 58445 D.

SPECIAL MOTORS.

Alcohol Engines.

Use of Alcohol Engines in Europe. George E. Walsh. Remarks on the interest shown in these engines, and on some of the recent types. 1500 w. Ir Age—Oct. 22, 1903. No. 58468.

Carbon Disulphide.

Graphics of Carbon Disulphide, with Formulas and Vapor Table. Thomas M. Gardner. Shows the properties of this vapor, and its value as a working fluid for heat engines. 2000 w. Jour Fr Inst —Oct., 1903. No. 58290 D.

Carburetter.

A Paraffine Carburetter. Hugh Dolnar. An illustrated article explaining how paraffin is burned in the "Secor" engines. 1800 w. Autocar—Oct. 17, 1903. No. 58602 A.

The Improved Longuemore Carburetter. Illustrated description. 1500 w. Sci Am Sup—Oct. 10, 1903. No. 58374.

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Combustion.

Phenomena of Alcohol Combustion. C. C. Longridge. Describes a series of experiments which gave facts of interest bearing upon the chemical theory—that the descomposition of the fuel improved the combustion and efficiency. 1700 w. Engr, Lond—Oct. 2, 1903. No. 58302 A.

Gas Engine.

A New Two-Cycle Gas Engine (Un Nouveau Moteur à Deux Temps). H. André. A description of the Doué motor with single oscillating cylinder, the compression being effected on the front side of the piston. 1200 w. Revue Technique —Sept. 25, 1903. No. 58510 D.

Gas Power.

See Electrical Engineering, Generating Stations.

Internal Combustion.

The Present Status of the Heat Engine (Der Heutige Stand der Wärmekraftmaschinen). Rudolf Diesel. A discussion of the availability of liquid fuel in internal-combustion engines, with especial reference to the Diesel Motor. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1903. No. 58511 D.

Oil Engines.

The Diesel Motor (Diesel Motoren). O. Kritzler. A comparison of the economical performance of the Diesel motor with other internal-combustion engines, showing its high efficiency. 2500 w. De Ingenieur—Sept. 19, 1903. No. 58574 D.

Trial of a Diesel Oil Engine and Riedler Pump. Report of a trial made to ascertain whether the guarantees given by the makers had been fulfilled. 2300 w. Prac Engr—Sept. 25, 1903. No. 58195 A.

Petroleum Spirit.

Properties of Petroleum Spirit or Hexane. J. S. Fowler and B. T. McCormick. Reports an investigation made of the action of petroleum in a heat engine. 1200 w. Sib Jour of Engng—Oct., 1903. No. 58683 C.

Petrol Motor.

Detachable Petrol Motor for Boat Propulsion. Brief illustrated description of a type of motor used in France. 500 w. Engng—Oct. 16, 1903. No. 58477 A.

See also Mechanical Engineering, Automobiles.

STEAM ENGINEERING.

Boilers.

A Locomotive Boiler with Water-Tube Firebox. An illustrated detailed description of the invention of J. Brotan, an Austrian engineer. Abstracted from an article in the *Zeitschrift des Oesterr. Ing. u. Arch. Vereins.* 2500 w. Eng News—Oct 1, 1903. No. 58182.

The Schutte Boiler and its Application to River Boats (Des Schütte-Kessel und seine Verwendung auf Flussschiffe). H. Hildebrandt. Illustrating a combined fire-tube and water-tube boiler, suitable for small boats. 2000 w. Zeitsch d Ver Deutscher Ing—Oct. 10, 1903. No. 58519 D.

Boiler Testing.

Diagrammatic Boiler Testing. W. H. Booth. Showing the advantage of a graphic record and the manner of preparing the diagram. 2000 w. Power—Oct., 1903. No. 58157 C.

Break Downs.

Engine Breakdowns. Michael Longridge. Particulars of steam, gas, and oil engine breakdowns, with the lessons they teach, taken from the annual report of the chief engineer of the Engine, Boiler & Employers' Liability Ins. Co. 5800 w. Mech Engr—Sept. 26, 1903. No. 58196 A.

Cylinder Clearance.

Effect of Cylinder Clearance upon the Quantity of Steam Consumed in Doing Specific Work, with Special Reference to Locomotive Practice. Ira C. Hubbell. A study of this subject, followed by discussion. 13500 w. N Y R R Club—Sept. 18, 1903. No. 58686.

Engine Bearings.

The Bearings of Naval Engines. Suggestions, based on experience, on the lubrication, adjustment, etc. 1800 w. Engr, Lond—Oct. 16, 1903. No. 58483 A.

Engine Friction.

The Distribution of Friction in an Engine and Shafting. Thomas L. Wilkinson. A discussion of friction loss, lubrication, and general practice. 3000 w. Min Rept—Sept. 24, 1903. No. 58164.

Engines.

The Newcomen Engine. Henry Davey. Facts of interest in regard to the invention and construction of the first steam-engine—the Atmospheric Engine of Newcomen. Illustrations, with ten appendices. 13000 w. Inst of Mech Engrs—Oct. 16, 1903. No. 58607 D.

Engine Test.

Test of a Compound Engine. E. F. Williams. Gives briefly the results of preliminary economy tests of a vertical compound engine at the New York Navy Yard. 900 w. Power—Oct., 1903. No. 58158 C.

Exhaust Steam.

The Utilization of Exhaust Steam (Die Ausnutzung des Auspuffdampfes). Julius Divis. Discussing especially the Rateau steam accumulator and the use of ex-

haust steam in low-pressure steam turbines. Two articles. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 19, 26, 1903. No. 58551 each D.

Feed Water

Feed-Water Purification. Walter W. Edwards. Part first considers the mechanical methods employed. 2200 w. Engr, U. S. A.—Oct. 15, 1903. Serial. 1st part. No. 58395 C.

Some Sources of Error in Water Treatment. H. Spencer Flynt. A review of accepted methods of purification of waters for boiler feed, showing the necessity for intelligent supervision and care to avoid either under or over treatment. 2000 w. Engng Mag—Nov., 1903. No. 58585 B.

Water-Softening Plants, Pennsylvania Co. Describes the plant at Middlepoint, Ohio, where a machine capable of softening 10,000 gallons of water an hour is in use. 700 w. R R Gaz—Oct. 2, 1903. No. 58267.

Water Treatment in Railroad Operation. G. R. Henderson. A brief paper on what has been accomplished and the results of treating water before it is taken on the tender. Followed by lengthy general discussion. 7500 w. W Ry Club—Sept. 22, 1903. No. 58367 C.

Flow.

Flow of Steam or Gases Through a Nozzle. Sanford A. Moss. An explanation of the expansion of Gases, the effect of the shape of nozzles, etc. 1800 w. Engr, U. S. A.—Oct. 15, 1903. No. 58396 C.

Governor.

The Racing Check: A New Marine Engine Governor. Illustrated description. 1000 w. Prac Engr—Oct. 16, 1903. No. 58496 A.

Mechanical Draft.

On the Design and Testing of Centrifugal Fans for Induced Draught and Other Purposes. W. Gilbert. Read before the Civil & Mech. Engrs.' Soc. Somewhat supplementary to a previous paper read in 1895. Describes installations of fans of the larger sizes, and gives particulars of some tests. 4000 w. Engng—Oct. 9, 1903. No. 58438 A.

Safety Valves.

Notes on Safety Valve Practice. R. S. Hale. Discusses the size of valves to be used and ways of improving safety valve practice. 1600 w. Engr, U. S. A.—Oct. 1, 1903. No. 58243 C.

Steam Production.

Steam Production in Locomotives. R. Gordon Sharp. Discusses firing and the causes of poor combustion, suggesting means of remedying. 2000 w. Engr, Lond—Oct. 16, 1903. No. 58484 A.

Steam Turbines.

Advantages of Steam Turbines for Textil Mills. Austin R. Dodge. Condensed from paper read before the New England Cotton Mfrs.' Assn. Describes various types of turbines in use and considers their adaptability to the requirements of textile mills. 2000 w. Ill. Eng News—Oct. 22, 1903. No. 58634.

Elementary Theory of the Steam Turbine (Théorie Elémentaire des Turbines à Vapeur). A. Rateau. Deriving the fundamental equations governing the action of fluid jets upon rotating wheels, with applications to impact and reaction steam turbines. 5000 w. Revue de Mécanique —Sept., 1903. No. 58527 E + F.

Stokers.

Mechanical Stokers. Thomas L. Wilkinson. The present article reviews the causes that have stimulated the invention of mechanical stokers. 1200 w. Min Rept—Oct. 15, 1903. Serial. 1st part. No. 58451.

Stoking-Indicators.

Kilroy's Stoking-Indicators. An illustrated description of an apparatus devised with the object of facilitating the uniform firing of boiler furnaces, thus securing a maximum coal efficiency and a minimum of smoke production. 1500 w. Engng—Oct. 2, 1903. No. 58294 A.

Superheating.

Test of a Superheated Steam Plant at Niechcice, Russia (Abnahmeversuche an einer Heissdampfanlage in Niechcice). M. Westphal. Data and results of test of a compound engine of 240 horse power, with steam superheated 350 degrees C. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1903. No. 58514 D.

Valve Gears.

The Valve Gears of Modern Mill Engines. Charles Hurst. An illustrated description of recent types. 3300 w. Feilden's Mag—Oct., 1903. No. 58471 B.

MISCELLANY.

Aeronautics.

A Balloon Trip Over the Alps. An account of the recent trip made by Capt. Spelterini, accompanied by a party of aeronauts and scientists. 1000 w. Sci Am Sup—Oct. 24, 1903. No. 58652.

The Failure of Langley's Aerodrome. A brief illustrated account of the last experiment with this machine, and its disaster, with explanations. 800 w. Sci Am —Oct. 17, 1903. No. 58405.

The Flight of Birds Mechanically Studied. Emile Guarini. An illustrated study. 1200 w. Sci Am—Oct. 10, 1903. No. 58368.

The Lebaudy Airship. A short illus-

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trated description with account of preliminary experiments. 1700 w. Sci Am Sup—Oct. 10, 1903. No. 58373.

Automatic Counting.

Automatic Apparatus for Counting and Registering Casks. Illustrates and describes an invention of Thomas Forsyth designed for the accurate counting, measuring and registering of casks or barrels and recording the result. 800 w. Engng—Oct. 16, 1903. No. 58478 A.

Band-Saw.

Horizontal Log Band-Saw. An illustrated description with statement of advantages claimed. 1800 w. Engng—Oct 16, 1903. No. 58479 A.

Blowpipe.

The Oxygen-Acetylene Blowpipe (Le Chalumeau Oxy-Acétylénique). E. Fouché. A description of the conditions under which acetylene and oxygen may be successfully used in the blowpipe to produce very high temperatures, with sectional drawing of blowpipe. 3000 w. Génie Civil—Sept. 26, 1903. No. 58502 D.

Glass Working.

The Mechanical Manufacture of Bottles (Fabrication Mécanique des Bouteilles). L. Appert. A review of the various mechanical processes which have been proposed for making glass bottles, concluding with the Boucher machine, now in most successful operation. 6000 w. Bull Soc d'Encour—Sept., 1903. No. 58525 G.

The Sievert Process of Mechanical Glass Blowing. An illustrated article describing practical applications of this process. 800 w. Sci Am—Oct. 3, 1903. No. 58171.

Heating.

Heating Experiments with Oils and Manufactured Gas. B. T. Galloway. Notes from the *Florists' Exchange*, respecting experiments with some new devices for heating water for use in radiators, with gas and oil as fuels. Ill. 2200 w. Am Gas Lgt Jour—Oct. 26, 1903. No. 58663.

Refrigeration.

A Comparison of Old and Recent Tests of Ammonia Compression Refrigerating Machines (Vergleich Aelterer und Neuerer Versuchsergebnisse von Ammoniak-Kompressions-Kältemaschinen). G. Döderlein. Giving tabulated results of tests, and deducing formulas for use in computation. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1903. No. 58518 D.

The Miller System of Mechanical Refrigeration. Illustrated description of an ice-making machine operated from the car axle. 2500 w. R R Gaz—Oct. 23, 1903. No. 58644.

Residence Heating.

Heating and Ventilating in the Carnegie Residence, New York. An illustrated description of an example of fine workmanship. The heating plant is mainly an indirect one, but is supplemented by exhaust fans. 4500 w. Eng Rec—Oct. 3, 1903. No. 58263.

MINING AND METALLURGY

COAL AND COKE.

Borings.

Coal Borings in the Pas-de-Calais Coal-Field. Condensed report of recent mining explorations made in this vicinity. 1000 w. Col Guard—Oct. 16, 1903. No. 58482 A.

Cannel Coal.

Kerosene Shale, or Cannel Coal Seams at Preolenna, Tasmania. Interesting details from the report of W. H. Twelvetrees. Map. 900 w. Ir & Coal Trds Rev—Oct. 2, 1903. No. 58306 A.

Coal Fields.

Barela Mesa Coal Field. J. E. McLaughlin. Information concerning deposits near Trinidad, Colorado. 700 w. Mines & Min—Oct., 1903. No. 58156 C.

Coal Storage.

The Storage of Steam Coal Under Water. Two letters written by Mr. John Macaulay to the London *Times*, on experiments carried out to find the best method of storing large quantities of coal. 2700 w. Prac Engr—Oct. 2, 1903. No. 58276 A.

Coal Syndicate.

See Industrial Economy.

Glapwell Colliery.

Notes on Glapwell Colliery. Maurice Deacon. Describes the surface plant, ventilation and underground arrangements. General discussion. 4500 w. Col Guard—Oct. 9, 1903. No. 58428 A.

Gob-Fires.

Gob-Fires, Their Theory and Practice. George Farmer. Read before the Yorkshire Branch of the Nat. Assn. of Col. Mgrs. Deals with spontaneous combustion, and the problem of gob-fires, their causes, prevention, and means of extinction. 5800 w. Ir & Coal Trds Rev—Sept. 25, 1903. No. 58219 A.

Indian Territory.

Coal Mining in the Indian Territory—

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The Southwestern Field. W. R. Crane. Map and illustrated description of this field, the methods of mining, cost, products, etc. 4200 w. Eng & Min Jour—Oct. 17, 1903. No. 58461.

Japan.

The Takasima Coal Mines of Nagasaki, Japan. E. W. Hardin. A finely illustrated article describing mines having unusual features. 1700 w. Page's Mag—Oct., 1903. No. 58469 B.

New Zealand.

The State Coal Mines. Reports of the Point Elizabeth coal mine, and the Seddonville coal mine. 2500 w. N Z Mines Rec—Sept. 16, 1903. No. 58489 B.

Sinking.

Sherwood Colliery Sinking. J. W. Fryar. Describes the sinking to a depth of 1,302 ft., the diameter of the shaft being 20 ft. The time occupied was 54 weeks. Discussion. 5000 w. Col Guard —Oct. 2, 1903. No. 58291 A.

COPPER.

Arizona.

Copper Deposits of Bisbee, Arizona. Condensed from Ransome's contribution to U. S. Geol. Survey. Describes the geology of the district and occurrence of ores. 1500 w. Min Rept—Oct. 1, 1903. No. 58222.

British Columbia.

Ore Quarrying in the Boundary District, British Columbia. E. Jacobs. A well illustrated description of the open copper mines of the district, showing the great field for new methods and machinery. 4000 w. Engineering Magazine—Nov., 1903. No. 58586 B.

Concentration.

Method of Concentrating at La Cananea. Martin Schwerin. Describes the concentrating plant of the Greene Consolidated Copper Co. in Mexico, designed for a capacity of 600 tons per day. 1500 w. Eng & Min Jour—Sept. 26, 1903. No. 58132.

Cyandide Assay.

Improvements in the Cyanide Assay for Copper. Thorn Smith. Describes the methods now used by the writer, which he considers "the best by far of the volumetric methods." 1200 w. Eng & Min Jour—Oct. 17, 1903. No. 58462.

GOLD AND SILVER.

Africa.

Gold in the Dioritic Rock from Mashonaland. J. E. Spurr. A microscopic study of a specimen of auriferous dioritic rock. Ill. 1100 w. Eng & Min Jour—Oct. 3, 1903. No. 58255.

Amalgamation.

Raw Copper Plates. On the selection and care of these plates when used for amalgamation of gold ores; the preparation and treatment necessary to secure good results. 2500 w. Min & Sci Pr—Sept. 19, 1903. No. 58119.

The Practice of Amalgamation. W. H. Kritzer. Notes on the manipulation of mercury and care of plates. 2200 w. Pacific C Min—Oct. 10, 1903. No. 58382.

British Columbia.

Through the Lardeau. Notes of a trip through this country where unusually rich gold-bearing ore has recently been found. General information with map. 5400 w. B C Min Rec—Oct., 1903. No. 58319 B.

California.

The Dorleska Gold Mine. H. Z. Osborne. An account of the rapid development of this mine in Trinity Co., California, with illustrations. 2000 w. Min & Sci Pr—Oct. 17, 1903. No. 58611.

Costs.

Mining Costs on the Rand and in New Zealand. From the annual report on portions of the West Coast Gold Fields for 1902. A comparison of expenses of working. 2000 w. N Z Mines Rec—Sept. 16, 1903. No. 58488 B.

Cyaniding.

Consumption of Zinc on Cyanide Plants. Walter H. Virgoe. Considers the loss due to mechanical and to chemical causes, and the excessive losses, discussing questions bearing upon this subject and defending the use of zincic potassic-cyanide. 9000 w. Jour Chem & Met Soc of S Africa—Aug., 1903. No. 58193 E.

Gold Fields.

Gold Fields of the Atlantic Slope. C. L. Dignowity. Condensed from Trans. Am. Min. Cong., Deadwood, S. D. A brief account of the deposits in N. Carolina, Virginia and the Southern field, the conditions, methods, etc. 1800 w. Min & Sci Pr—Sept. 19, 1903. No. 58120.

Hydraulic Mining.

Hydraulic Mining in Southern Oregon. Dennis H. Stovall. An illustrated account of placer mining, and the extensive placer field of this region. 1300 w. Min & Sci Pr—Oct. 3, 1903. No. 58331.

Mexico.

The Mines of the Pinitos and Azul Mountains, Sonora, Mexico. Reginald W. Petre. Outlines the history of the region, explaining why the gold and silver mines remain undeveloped. 1600 w. Eng & Min Jour—Sept. 26, 1903. No. 58134.

Montana.

Big Indian Mine. Colin McIntosh. Illustrated description of a Montana gold mine and mill. The method of mining is by the open-cut and mill-hole system.

We supply copies of these articles. See page 479.

1800 w. Min & Sci Pr—Oct. 10, 1903. No. 58454.

Nicaragua.

Gold Fields of Eastern Nicaragua. Information concerning the mineral regions, labor, wages, water, wood, etc. 3000 w. U S Cons Repts, No. 1774—Oct. 14, 1903. No. 58365 D.

Ore Treatment.

The Greenawalt Electro-Chlorination Process. John E. Greenawalt. An illustrated detailed description. 1400 w. Min Rept—Oct. 8, 1903. No. 58317.

Quartz Milling.

Notes on the Common Practice of Quartz Milling on the Rand. Discussion of the paper by Fraser Alexander. 3000 w. Jour Chem & Met Soc of S Africa—Aug., 1903. No. 58192 E.

Queensland.

Gold Workings in the Perry Scrub, Burnett District. Lionel C. Ball. Gives the location, topography, geology, etc., describing the workings. Map. 5000 w. Queens Gov Min Jour—Aug. 15, 1903. No. 58189 B.

Silver Ores.

The Occurrence of Lead, Cobalt and Nickel Ores Containing Silver, near Pressnitz, Bohemia. (Die Vorkommen von Silberhältigem, Bleiglanz, Kobalt und Nickelerz bei Pressnitz im Böhmischen Erzegebirge). Josef Lowag. A general description of the geological conditions. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 26, 1903. No. 58552 D.

Slimes.

What Constitutes a Slime? W. J. Sharwood. Calls attention to some of the definitions suggested as applied to certain classes of tailings, or crushed ore, in connection with lixiviation and concentration processes. 1400 w. Eng & Min Jour—Oct. 10, 1903. No. 58347.

Supply.

The Supply of Gold. Address of Mr. George E. Roberts, Director of the United States Mint, at American Mining Congress. 2500 w. Min Rept—Oct. 8, 1903. No. 58318.

Thunder Mountain.

Thunder Mountain Region. Illustrated description of this gold region of Central Idaho, giving information in regard to the deposits, development, etc. 2000 w. Min Rept—Sept. 24, 1903. No. 58165.

Transvaal.

Developments in the Heidelberg District, Transvaal. T. Lane Carter. A report of recent investigations made in this gold mining district. Ill. 1200 w. Eng & Min Jour—Oct. 17, 1903. No. 58463.

IRON AND STEEL.

Alloys.

Alloys Used for Steel Making. Dr. J. Ohly. Considers the compositions and effects upon the properties of steel of some alloys now in use. 2200 w. Mines & Min—Oct., 1903. Serial. 1st part. No. 58150 C.

Bilbao.

The Bilbao Iron Mines. C. Mackay-Heriot. Outlines the history of these Spanish mines, describing the geological conditions, ore occurrence, methods of extraction, etc. Ill. 2800 w. Eng & Min Jour—Oct. 3, 1903. No. 58258.

Castings.

See Mechanical Engineering, Machine Works and Foundries.

Cast Iron.

See Mechanical Engineering Materials.

Iron Works.

See Mechanical Engineering, Machine Works and Foundries.

Manganese Steel.

See Mechanical Engineering, Materials.

Nickel Steel.

See Mechanical Engineering, Materials.

Open-Hearth.

Open-Hearth Steel Making and Blast Furnace Gas in Gas Engines. Peter Eyermann. From a paper read before the Civ. Engrs. Club of Cleveland. Illustrates types of gas engines suited for the use of blast-furnace gas, and discusses the economies to be effected in the consumption of coal, etc. 5000 w. Ir Trd Rev—Oct. 22, 1903. No. 58612.

Steel.

Testing Brittleness of Steel. E. G. Izod. Read before the British Assn. An illustrated description of a pendulum apparatus for testing steel as regards brittleness. 1500 w. Engng—Sept. 25, 1903. No. 58210 A.

Steel Mills.

See Mechanical Engineering, Machine Works and Foundries.

Steel Trade.

See Industrial Economy.

MINING.

Accidents.

Fatal Accidents in Coal Mines of North America. Frederick L. Hoffman. Some facts bearing upon the gradual increase in the fatality rate. 900 w. Eng & Min Jour—Sept. 26, 1903. No. 58133.

Accounting.

A Card System for Mine Supply Accounts. F. W. Denton. Read before the Lake Superior Min. Inst. Describes a method by which the amount and value of

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supplies on hand can always be known. 1800 w. Mines & Min—Oct., 1903. No. 58152 C.

Mine Accounting. Walter M. Jeffery. Read before the Lake Superior Min. Inst. Shows the importance of uniform systems for all mines under same ownership. 3400 w. Mines & Min—Oct., 1903. No. 58151 C.

Electric Transmission.

See Electrical Engng, Transmission.

Intake Tunnel.

Intake Tunnel for the Champion Mill, at Painesdale, Mich. F. W. O'Neil. Abstract of a paper for meeting of the Lake Superior Min. Inst. An illustrated description of the work, with reasons for the method adopted. 4500 w. Eng News—Oct. 1, 1903. No. 58181.

Mine Cars.

Car for Handling Rock at Mines. L. L. Logan. An illustrated description of an arrangement for handling and dumping mine cars loaded with rock. 1000 w. Mines & Min—Oct., 1903. No. 58154 C.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miner's Phthisis. Discussion of paper by A. Heymann. 1200 w. Jour Chem & Met Soc of S Africa—Aug., 1903. No. 58191 E.

Mine Signalling.

Signalling Between Levels. F. B. Allen. Notes on a new system of signalling at Bayley's gold mines, Coolgardie. Ill. 900 w. N Z Mines Rec—Aug. 17, 1903. No. 58179 B.

Mine Watering.

A Portable Tank for Watering Roadways in Mines. W. Galloway. Read before the South Wales Inst. of Engrs. Briefly describes various appliances that have been used, especially an invention of the writer's, in which compressed air expels the water. Ill. 1600 w. Ir & Coal Trds Rev—Oct. 2, 1902. No. 58307 A.

The Spraying or Watering Problems of Dusty Mines. James Ashworth. Considers dangers connected with spraying, as shown by reports of various experiments and dust explosions. 4500 w. Mines & Min—Oct., 1903. No. 58147 C.

Preparation.

The Mechanical Preparation of Minerals (La Préparation Mécanique des Minerais). Paul Machavoine. A discussion of methods of separation and concentration of ores, based not only upon the physical properties, but also upon the local conditions of labor, transport, etc. 4000 w. Mem Soc Ing Civ de France—Aug., 1903. No. 58572 G.

Roads.

Good Roads for Mines. James W. Abbott. Read at the Am. Min. Cong. The importance of highway improvement, particularly in its effect upon the mining industry. 2000 w. Min Rept—Sept. 24, 1903. No. 58166.

Rock-Salt.

Mining and Manufacture of Rock Salt. F. E. Englehardt. An illustrated description of methods used in the mines of New York State. 2500 w. Sci Am Sup—Oct. 3, 1903. Serial. 1st part. No. 58176.

Safety Catches.

Safety Catches for Mine Haulage Apparatus (Sicherheitsvorrichtungen an Bremsbergen). Gustav Ryba. Describing a number of forms of safety brakes and catches for checking the fall of cars and cages on mining inclines and hoists. Two articles. 1 plate. 4000 w. Osterr Zeitschr f Berg u Hüttenwesen—Oct. 3, 10, 1903. No. 58553 each D.

Safety Device.

The Karlik-Witte Safety Device for Mine Hoisting Machinery (Der Sicherheitsapparat für Fördermaschinen Patent Karlik-Witte). The apparatus includes indicators showing the position of the cages in the shaft and an automatic brake to prevent overwinding. 2500 w. Glückauf—Sept. 19, 1903. No. 58547 D.

Shaft Sinking.

Progress at the Dover Colliery: Shaft Sinking by the Kind-Chaudron System. An illustrated account of the progress made at No. 2 pit, where great quantities of water were encountered. 1200 w. Col Guard—Sept. 25, 1903. No. 58204 A.

Report upon the Methods of Transporting Material in the Mines of Upper Silesia (Bericht über das Schlammversatzverfahren auf den Oberschlesischen Bergwerken). K. Müller & H. Hussmann. A description of the methods employed for raising mud, sand and semi-fluid materials in sinking mine shafts. 6000 w. 1 plate. Glückauf—Sept. 26, 1903. No. 58548 D.

Sinking and Equipping No. 9 Shaft, at Ashland Mine, of the Cleveland-Cliffs Iron Company, at Ironwood, Michigan. H. F. Ellard. Read before the Lake Superior Min. Inst. An illustrated detailed description of the work. 3200 w. Mines & Min—Oct., 1903. No. 58153 C.

Timbering.

Drift Timbering. W. H. Storms. Sketches illustrating some of the principles of drift timbering under the conditions usually encountered. 1500 w. Min & Sci Pr—Oct. 10, 1903. Serial. 1st part. No. 58332.

Veins.

Identity and Continuity of Veins. Some

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extracts from the work of C. H. Lindley on mines, discussing mining laws bearing upon veins, with comments. 2000 w. Min & Sci Pr—Oct. 10, 1903. Serial. 1st part. No. 58453.

MISCELLANY.

Antimony.

The Mineralogy, Metallurgy and Commercial Application of Antimony. Dr. J. Ohly. On the value and uses of antimony ore. 2000 w. Min Rept—Oct. 1, 1903. No. 58223.

Asbestos.

The Production of Asbestos in 1902. Joseph Hyde Pratt. Condensed from a Bul. of the U. S. Geol. Survey. Concerning the sources of supply and the production. 1200 w. Eng News—Oct. 15, 1903. No. 58404.

Asphaltum.

The California Asphaltum Industry. F. H. Minard. Outlines the occurrence and character of the deposits of crude oil in California, and the process of refining for asphaltum. Ill. 3500 w. Eng & Min Jour—Oct. 3, 1903. No. 58257.

Diamonds.

The Mechanical Equipment of the Kimberley Diamond Mines. Charles V. Allen. Mr. Allen's second article deals with the electric, pneumatic, steam and general machinery of advanced design in use at Kimberley. 4000 w. Engineering Magazine—Nov., 1903. No. 58583 B.

Lead.

The Metallurgy of Lead. H. O. Hofman. Reprinted from an article in the new volumes of the *Encyclopedia Brittanica*. Describes methods in use. 4000 w. Tech Qr—Sept., 1903. No. 58386 E.

Mineral Industry.

Notes on the History of the Mineral Industry in the Nineteenth Century. Willet G. Miller. An interesting review. 10000 w. Can Min Rev—Sept. 30, 1903. No. 58228 B.

Petroleum.

The Petroleum Districts and Mud Volcanoes of Java. A. Bosch. An illustrated article describing the oil deposits of Java. 1200 w. Sci Am—Oct. 10, 1903. No. 58369.

The Refining of California Petroleum. Dozier Finley. From the *California Jour. of Tech.* Considers the character of these oils, their applications, methods of refining, etc., comparing the products with the Eastern. 3800 w. Pacific C Min—Sept. 26, 1903. No. 58221.

Platinum.

Platinum. Remarks on the many uses of this metal, its production, the principal deposits known, etc. 1200 w. Aust Min Stand—Sept. 3, 1903. No. 58188 B.

Quicksilver.

Quicksilver Reduction at New Almaden, Cal. Walter W. Bradley. A short description of the operations at the reduction works, with illustration. 1000 w. Min & Sci Pr—Sept. 26, 1903. No. 58229.

The Quicksilver Deposits of Oregon. W. B. Dennis. Reviews the condition of quicksilver, the steady decline in production, and gives an account of the deposits discovered in Oregon. Ill. 3400 w. Eng & Min Jour—Oct. 10, 1903. No. 58346.

Thermite.

Goldschmidt Method of Metallurgy and High Temperature Production by Means of Thermite. B. Palmer Caldwell. An explanation of thermite and its action. 2000 w. Jour Assn of Engng Socs—Aug., 1903. No. 58168 C.

Uranium.

Uranium. Describes this metal and some of its oxides which have been found useful. 1700 w. Aust Min Stand—Aug. 27, 1003. No. 58187 B.

Vanadium.

The Applications of Vanadium in Metallurgy (Le Vanadium en Métallurgie). S. Marsollan. A study of the influence of vanadium upon iron and steel, showing the increase produced in resistance. Two articles. 4000 w. Revue Technique—Sept. 25, Oct. 10, 1900. No. 58508 each D.

Vanadium. Describes this rare metal, giving much information concerning it. 1800 w. Aust Min Stand—Aug. 20, 1903. No. 58186 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Acceleration Tests.

Acceleration Tests on the Great Eastern of England. A detailed account of tests made with a new 10-coupled suburban tank engine. 900 w. R R Gaz—Sept. 25, 1903. No. 58139.

Fast Trains.

The Fastest Trains in the United States. W. A. Schulze, in *Zeitung des Vereins.* Three short articles on the speed of American trains, giving tables. 3800 w. Bul Int Ry Cong—Sept., 1903. No. 58274 E.

Grain.

Relations of Railroads to the Grain

Trade. F. A. Delano. Discusses points in facilitating the economical and rapid handling of grain, the improvements made and needed. 3700 w. Ry Age—Oct. 16, 1903. No. 58448.

Resistance.

Some Notes on Train Resistance. C. F. Dendy Marshall. Investigates details given by C. J. Bowen Cooke, of experiments carried out with the dynamometer van on the North-Western Railway, and the figures given by J. A. F. Aspinall in a paper read before the Inst. of Civ. Engrs. 2800 w. Engr, Lond—Oct. 2, 1903. No. 58300 B.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Maintenance of Air Brakes Under Freight Cars. W. C. Hunter. Extracts from a paper read before the Canadian Ry. Club. Concerning the repairs and the methods of the Intercolonial Ry. 1200 w. R R Gaz—Oct. 16, 1903. No. 58397.

Axle Failures.

Axle Failures in Germany. Figures taken from an article by M. E. Biard in the *Revue Generale des Chemins de Fer*, which gives an analysis of failures for the years 1888 to 1900. 1200 w. R R Gaz—Oct. 9, 1903. No. 58348.

Brake Tests.

Some Competitive High-Speed Brake Tests. Gives tabulated results of tests made by the Central Railroad of New Jersey. 800 w. Loc Engng—Oct., 1903. No. 58285 C.

Cars.

Composite Gondola Cars, C. B. & Q. R. R. An illustrated description of 100,000 lbs. capacity cars. 1000 w. Ry & Engng Rev—Oct. 24, 1903. No. 58662.

Steel Frame Side Door Suburban Cars of the Illinois Central R. R. Full illustrated detailed description of this new type. 3200 w. Ry Mas Mech—Oct., 1903. No. 58605.

Counterbalancing.

Counterbalancing Locomotive Driving Wheels. Editorial reviewing early rules for the counterbalancing of driving wheels. 1300 w. Loc Engng—Oct., 1903. No. 58161 C.

Driving Wheels.

The Unresilient Driving Wheel. Editorial on the need of an invention to soften the blow of tires on the track and to reduce the noise. 900 w. Loc Engng—Oct., 1903. No. 58162 C.

Feed Water.

See Mechanical Engng., Steam Engineering.

Locomotive Boilers.

Special Features in the Design of Locomotive Boilers and Fireboxes. Charles S. Lake. Mr. Lake's second paper treats especially of recent examples of boiler design in British locomotives, including the use of water tubes, corrugated furnaces and superheaters. 3000 w. Engineering Magazine—Nov., 1903. No. 58584.

Locomotive Design.

Locomotive Proportion. F. K. Caswell. The second in a series of graphical charts relating to locomotive design, with notes. 1000 w. Ry & Engng Rev—Oct. 3, 1903. No. 58311.

Locomotive Frames.

A Rational Method of Design of Locomotive Frames. Abstract of a paper by G. S. Edmonds, presented at meeting of the Pacific Coast Ry. Club. Gives facts based on the examination of some 100 designs of representative product. 1500 w. R R Gaz—Oct. 9, 1903. No. 58350.

Locomotives.

A New Consolidation Locomotive for the Long Island Railroad. An illustrated description of Engines with Wooten type of boilers, having grates adapted for burning either lump or fine anthracite or bituminous coal, or a mixture. 300 w. Ry Age—Oct. 9, 1903. No. 58326.

Big Locomotives and the Compound. Editorial discussion of the big engines, their failures, and how to make them satisfactory. 900 w. Am Engr & R R Jour—Oct., 1903. No. 58239 C.

Class D2 Mogul (2-6-0) Locomotive for the "Soo Line." Illustration with general description. 500 w. R R Gaz—Oct. 23, 1903. No. 58645.

Continental Locomotive Types. Charles S. Lake. Begins a general survey of the principal modern types used on the continent. 1200 w. Prac Engr—Oct. 16, 1903 Serial. 1st part. No. 58495 A.

Experiments with a New Type of Compound Locomotive in Italy. The first of a series of articles describing the new type in use on the Adriatic railways, its development and working results. The boiler is reversed on the frames so that the firebox fits into the space above the bogie trucks. 3500 w. Engr, Lond—Oct. 2, 1903. No. 58299 A.

Heaviest Locomotive Ever Built. Illustration and chief characteristics of the 2-10-2 type, tandem compound, built for the A. T. & S. F. Ry. 200 w. Am Engr & R R Jour—Oct., 1903. No. 58240 C.

New Passenger Locomotives. Illustration, with description of the Pacific, or 4-6-2 type, passenger engine for the C., R. I. & P. Ry. 500 w. Am Engr & R R Jour—Oct., 1903. No. 58237 C.

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New 2-8-0 Freight Locomotive, N. & W. Ry. Illustrated description of interesting features. 700 w. Ry & Engng Rev—Sept. 25, 1903. No. 58169.

Note on Modern Locomotives. P. F. Kupka. A sketch of the present condition of locomotive building, limited to the last five years, and to heavy locomotives. Ill. 2000 w. Bul Int Ry Cong—Sept., 1903. No. 58273 E.

Philadelphia & Reading Double-End Interurban Engine. Illustration, elevation, cross sections and brief description of an engine for suburban service. 400 w. Ry Age—Sept. 25, 1903. No. 58118.

Pittsburg & Lake Erie Atlantic Locomotive. Illustrated description of engine for hauling heavy passenger trains. 700 w. Ry Age—Oct. 16, 1903. No. 58449.

Some Notes on Recent Fast Passenger Locomotives. Notes the greatest development of passenger locomotives since 1900, giving illustrations of designs. 1100 w. Sib Jour of Engng—Oct., 1903. No. 58684 C.

Tandem Compound "Santa Fe" Type (2-10-2) Locomotive for the Santa Fe. Illustrated descriptions. 500 w. R R Gaz —Oct. 9, 1903. No. 58351.

Ten-Wheel Express Locomotive. Illustrated description of a large engine to be used in service between London and Glasgow. 600 w. Engng—Sept. 25, 1903. No. 58207 A.

The Proportions of Modern Locomotives. Lawford H. Fry. Investigations covering over 250 locomotives, showing the tendencies of American practice, and comparing the dimensions. Also discussion. 13,600 w. Pro N Y R R Club—Sept. 18, 1903. No. 58685.

Motor Coach.

Great Western Railway Steam Motor Carriage. Illustrated description of a coach recently put in service in England. 600 w. Engr, Lond—Oct. 16, 1903. No. 58485 A.

Steel Cars.

Steel Car Development. Historical review, with illustrated details of the more important designs, and discussion of the principles involved in their construction. 1800 w. Am Engr & R R Jour—Oct., 1903. Serial. 1st part. No. 58238 C.

Train Lighting.

Electric Train Lighting (Elektrische Zugsbeleuchtung). A description of the Vicarino system, as introduced on the Swiss Government railways. A dynamo driven from the car axle is used. 1500 w. Schweiz Bauzeitung—Sept. 19, 1903. No. 58554 B.

Two Systems of Using Acetylene Gas for Car Lighting. Abstract of a paper by E. G. Fisher read at meeting of the International Acetylene Assn. in Chicago; also a summary of the Elliott & Wilson system as given by another paper at the same meeting. 1800 w. Eng News—Oct. 1, 1903. No. 58180.

NEW PROJECTS.

Colombia.

Colombian Railway Concession to Americans. Report of a concession granted for the construction of a railroad connecting the capital, Medellin, with the lower reach of the Magdalena River and with the Department of the Cauca. 800 w. U S Cons Repts, No. 1772—Oct. 12, 1903. No. 58292 D.

Genoa.

New Connections to the Harbor of Genoa (Neu Abfuhrleinen des Hafens von Genua). E. Bavier. A discussion of the existing railway connections between Switzerland and Northern Italy and the port of Genoa, with suggestions for their extension. Three articles. 4000 w. Schweiz Bauzeitung—Sept. 26, Oct. 3, 10, 1903. No. 58556 each B.

Mountain Railways.

The Wildstrubel and Lötschberg Railways (Die Wildstrubel und die Lötschbergbahn). A discussion of the proposed railways for the connection of the Bernese Oberland with the Simplon. 1800 w. Schweiz Bauzeitung—Sept. 19, 1903. No 58555 B.

South Africa.

The Railways in Our New South African colonies. A review of the report of T. R. Price, on the working of the Central South African railway. 3300 w. Engr, Lond—Oct. 9, 1903. No. 58440 A.

Transcontinental.

The New Canadian Transcontinental Railway. An account of this important railway project, with maps. 9800 w. Eng News—Oct. 22, 1903. No. 58633.

The Transcontinental Railway. W. H. James. A statement of reasons which justify the construction of a railway from Kalgoorlie (W. A.) to Port Augusta (S. A.). 2800 w. Aust Min Stand—Sept. 10 & 17, 1903. 2 parts. No. 58604 each B.

PERMANENT WAY AND FIXTURES.

Auxiliary Tanks.

On the Use of Auxiliary Tanks for Increasing the Rate of Supply of Water Cranes. Ch. Coda. Illustrates and describes the system which has been successfully applied on the Rome-Pisa line. also a report on means for preventing the freezing of water in water supply installations, and economic methods for keeping water in tanks at constant temperature. 2200 k. Bul Int Ry Cong—Sept., 1903. No. 58272 E.

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Broad Gage.

Brunel and the 7-Ft. Gage. Herbert T. Walker. Reviews the engineering works of Isambard Kingdom Brunel, and gives an account of the 7-ft. gage laid for the Great Western Railway of England. Ill. 3000 w. R R Gaz—Oct. 16, 1903. No. 58400.

Cut-Off.

The Brilliant Cut-Off of the Pennsylvania Railroad at Pittsburg. Illustrated description of an important change to relieve the congestion of freight traffic at Pittsburg. 700 w. Ry Age—Oct. 16, 1903. No. 58447.

Improvements.

Norfolk & Western Road Improvements. George L. Fowler. An illustrated article, describing improvements in grades and alignment. 1800 w. R R Gaz—Oct. 2, 1903. No. 58266.

Recent Improvements on the Oregon Short Line R. R. W. P. Hardesty. An illustrated article describing trestles, bridges, &c., recently built, and improvements in roadbed, grades and curves. 2500 w. Eng News—Oct. 15, 1903. No. 58402.

Signals.

Experiments with the Krizik Block Signal System (Die Versuche mit der Blocksignale System Krizik). A. Prasch. Tests made on the Austrian State Railways with the Krizik system of automatic electric signals, operating by a contact made by the train. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 9, 1903. No. 58535 D.

Power Signalling. Brief illustrated description of an installation at York, England, on the North Eastern Railway Electric power is used. 800 w. Elec Engr, Lond—Oct. 16, 1903. No. 58497 A.

The New Collective Long Distance Signal System (Die Versuche mit der Leviers d'Itinéraires pour la Commande à Distance des Aiguilles et Signaux de Chemins de Fer). G. Bleynie. A detailed description of the Bleynie and Ducousso system, recently installed on the Chemin de Fer du Midi. 15000 w. 7 plates. Rev Gen des Chemins de Fer—Oct., 1903. No. 58536 H.

Stations.

New Stations on the Grand Trunk. Illustrations and brief descriptions of stations at Portland, Me., and at Flint, Lansing and Durand, Mich. 800 w. Ry Age—Sept. 25, 1903. No. 58117.

Terminals.

Improvement of Railway Terminal Facilities at St. Louis, Mo. Abstract of a committee's report considering needed improvements. 2500 w. Eng News—Oct. 29, 1903. No. 58679.

Track Laying.

The Improved Harris Track-Laying Machine. Illustrated description of the machine and its operation. 3300 w. Ry & Engng Rev—Oct. 10, 1903. No. 58376.

Track Tools.

Track Tools—Their Use and Abuse. From a paper by J. C. Rockhold, read before the Roadmasters' and Maintenance of Way Assn. The need of instructing men in regard to the proper use and care of tools, citing cases of bad practice. 2000 w. Ry & Engng Rev—Oct. 17, 1903. No. 58610.

Tracks.

General Track Work. From a paper by A. Morrison, read before the Roadmasters' and Maintenance of Way Assn. The importance of good drainage, good material, and various other points are considered. 1800 w. Ry & Engng Rev—Oct. 17, 1903. No. 58609.

Track Construction and Maintenance. Thomas W. Wilson. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. Discusses rails, joints, roadbed and paving, &c. 2200 w. St Ry Jour—Oct. 17, 1903. No. 58455 C.

Vesuvius.

The Vesuvius Railway (Le Chemin de Fer du Vésuve). A general description of the new railway from Naples to the funicular railway at the crater of Vesuvius. 5000 w. Rev Gen des Chemins de Fer—Oct., 1903. No. 58537 H.

Yards.

Norfolk and Western Yard Improvements. George L. Fowler. An illustrated article outlining the work undertaken. 3800 w. R R Gaz—Sept. 25, 1903. No. 58140.

MISCELLANY.

Eastern Europe.

The Railways of Dalmatia, Bosnia, and Herzegovina (Die Eisenbahnen von Dalmatien, Bosnien, und Herzegowina). J. R. V. Wenusch. A general descriptive account of the railway systems of the Balkan states, based on a tour of observation. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 18, 1903. No. 58532 D.

New Zealand.

New Zealand Railways. Editorial review of the annual report of these railways. 1800 w. Engng—Oct. 2, 1903. No. 58297 A.

Taxation.

Taxation of Freight Car Lines. Editorial discussion of some of the plans for taxing car lines now in vogue in the United States. 1800 w. Ry Age—Oct. 2, 1903. No. 58226.

We supply copies of these articles. See page 479.

STREET AND ELECTRIC RAILWAYS

Accounts.

The Province of the Street Railway Accountant. Henry W. Brooks, Jr. On the importance of the accountant's work, and some of the statistics needed by the general manager, with suggestions. 3500 w. St Ry Rev—Sept. 20, 1903. No. 58-131 C.

Alpine Railways.

The Service of Electricity in Climbing the Alps. Frank C. Perkins. Brief illustrated description of the Jungfrau and other mountain railways. 900 w. Sci Am Sup—Oct. 31, 1903. No. 58682.

Australia.

The Electric Tramways of Kalgoorlie, Western Australia. S. W. Childs. Brief description of a line for a city of about 30,000 people. 1600 w. Elec Rev, N Y—Oct. 24, 1903. No. 58622.

Bexley.

The Bexley Electric Tramways and Electric Lighting. Illustrated description of a recently inaugurated system in England. 2000 w. Elec Engr, Lond—Oct. 2, 1903. No. 58278 A.

Budapest.

Electric Railways of Budapest. Franz Köster. Illustrated description of the electric underground and surface railways and power plant construction. 2000 w. St Ry Rev—Sept. 20, 1903. No. 58128 C.

Claim Department.

Claim Department Methods in Brooklyn. George R. Folds. Gives a description of the reports required and the methods in use, with comments on this important work. 2300 w. St Ry Jour—Oct. 3, 1003. No. 58246 C.

Compressed Air.

Mekarski System of Compressed Air Locomotives as Used on Suburban Lines in Paris. Illustrated description of this system. 1600 w. Sci Am Sup—Oct. 17, 1903. No. 58414.

Crossings.

Steam and Electric Railway Crossings. Charles R. Barnes. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. Discusses grade crossing accidents and the best protection when the crossing is at grade. 2000 w. St Ry Jour—Oct. 17, 1903. No. 58458 C.

Denver.

Denver Tramway System. An illustrated detailed description of the new station of the Denver Tramway Power Co., and the high-tension transmission, and other features. 7500 w. St Ry Jour—Oct. 10, 1903. No. 58334 C.

Economics.

Economic Considerations Determining the Magnitude and Details of a Proposed Road. From advance proofs of "Electric Railway Economics," by W. C. Gotshall. 3000 w. St Ry Jour—Oct. 10, 1903. No. 58335 C.

Electric Locomotives.

Electric Mine Locomotives for Narrow Gauge (Elektrische Grubenlokomotiven für Schmalspur). Ernst Egger. Illustrated description of 3 ton electric locomotive for 488 millimetre gauge for the coal mines at Fünfkirchen, Hungary. 2000 w Elektrotech Zeitschr—Oct. 1, 1903. No 58565 B.

Electric Traction.

An Important Step in Electric Traction. Information concerning an experiment in progress on a suburban line near Berlin. The trial of a new motor, invented by an Austrian electrician, deriving its energy from a single-phase alternating current of 6,000 volts, delivered directly to the motor, apparently with entire success. Ill. 700 w. U S Cons Repts, No. 1769—Oct. 8, 1903. No. 58241 D.

Engine.

The Robb-Armstrong Engine for Electric Traction. Illustrated description of an engine much used in Canada and foreign countries. 1800 w. Tram & Ry Wld —Oct. 8, 1903. No. 58427 B.

Europe.

Electric Railways in Europe. An account of the recently resumed high-speed trials at Berlin, where a speed of 118 miles an hour was attained. 1500 w. Elec Rev, Lond—Oct. 2, 1903. No. 58281 A.

Fares.

Fares and Fare Protection. John F Ohmer. Abstract of a paper read before the Penn. St. Ry. Assn. Reviews the conditions and describes the Ohmer register and system. 3000 w. St Ry Jour—Oct. 3, 1903. No. 58248 C.

High Speed.

High-Speed Electric Traction at Berlin. Brief review of the trials on the Marienfelde-Zossen line and the great speed attained. Illustration of car used. 1200 w. U S Cons Repts, No. 1783—Oct. 24, 1903. No. 58474 D.

Interurban.

Auburn & Syracuse Electric Railway. An illustrated detailed description of this road and its equipment. Of interest be-

We supply copies of these articles. See page 479.

cause of the direct competition with steam lines. 2000 w. St Ry Jour—Oct. 3, 1903. No. 58244 C.

Colorado Springs and Interurban Railway System. Illustrated detailed description of the road and equipment. 3500 w. St Ry Jour—Oct. 3, 1903. No. 58245 C.

Freight Development by Interurban Roads. E. F. Seixas. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. An account of the development of this service in Canada. 2300 w. St Ry Jour—Oct. 17, 1903. No. 58459 C.

Interurban Freight and Express. An illustrated article describing the methods of the Electric Traction Co. of Cleveland, 2500 w. St Ry Jour—Oct. 24, 1903. No. 58613.

Interurban Train Dispatching. E. P. Wilcoxen. Read at Syracuse meeting of the N. Y. State. St. Ry. Assn. Describes principally the telephone system of despatching. 1200 w. St Ry Jour—Oct. 17, 1903. No. 58457 C.

Power Transmission for Interurban Lines. J. B. Storer. Read at Syracuse meeting of the N. Y. State St. Ry. Assn. Considers some of the possible improvements that may be made in electrical systems. 2000 w. St Ry Jour—Oct. 17, 1903. No. 58456 C.

The Columbus, London, and Springfield, and the Dayton, Springfield and Urbana Railways. H. C. Reagan. An illustrated detailed description of a fine interurban system in Ohio. 7000 w. St Ry Rev—Sept. 20, 1903. No. 58130 C.

The Utica & Mohawk Valley Railway. Illustrated description of an important electric railway system in Central New York. 9300 w. St Ry Rev—Oct. 20, 1903. No. 58660 C.

Main-Line Traction.

Steam or Electricity? (Dampf oder Elektrizität). Alfred Birk. A comparison of steam and electric power for the future attainment of high speeds on main-line railways, showing the possibilities of the latter. 5000 w. Oesterr Monatschr f d Oeff Baudienst—Oct. 10, 1903. No. 58578 D.

Multiple Unit.

The Multiple Unit System of Electric Traction (La Traction Elektrique et les Trains à Unités Multiples). Jean de Traz. Discussing the extending use of the multiple-unit system in the United States, and showing its applicability to local transport in France. 10000 w. Mem Soc Ing Civ de France—Aug., 1903. No. 58573 G.

New Zealand.

Electric Tramways in Auckland, New Zealand. Illustrated detailed description of an extensive system. 1300 w. St Ry Jour—Sept. 26, 1903. No. 58121 C.

Operation.

Hydraulics in Connection with Street Railway Operation. C. E. Parsons. Read at the St. Ry. Con. at Syracuse. Especially discusses the plants at Spier Falls and Mechanicsville, and their economy and reliability. 1500 w. St Ry Jour—Oct. 10, 1903. No. 58336 C.

Railway Motors.

Some Notes on the Operation of Railway Motors in Service. Clarence Renshaw. On the means of determining whether the loads carried by the motor are within its capacity. Results of actual tests, explaining method of equating the service loads. Also discussion. 7000 w. Trans Am Inst of Elec Engrs—June, 1903. No. 58617 D.

The Conditions Governing the Rise of Temperature of Electric Railway Motors in Service. Cary T. Hutchinson. A report of investigations made developing a method for determining the performance of any motor in service. 5700 w. Trans Am Inst of Elec Engrs—Oct., 1903. No. 58620 D.

Reports.

System of Reports of Denver City Tramway. Explains the extensive system in use, giving forms of blanks and general information. 3000 w. St Ry Jour— Sept. 26, 1903. No. 58122 C.

Switzerland.

Mountain Electric Road in Switzerland and the Sublin Hydraulic Plant. C. L. Durand. An illustrated description of the Bex-Gryon-Villars line, equipped on the Thury direct-current system. 3300 w. Elec Rev, N Y—Oct. 10, 1903. No. 58-338.

Trolley Omnibus.

The Trolley Omnibus. Illustrates and describes a type of trolley with self-contained electric motor, invented by Mr. Lombard Gerin. 2200 w. Trac & Trans—Oct., 1903. No. 58381 E.

Tunnel Ventilation.

The Ventilation of Deep-Level Underground Railways. A suggestion. B. Pontifex. Describes a scheme for automatically removing the foul air by suction pipes. 500 w. Elec Engr, Lond—Oct. 9, 1903. No. 58421 A.

Valtellina.

The Valtellina Electric Railway. An illustrated description of this line, which forms part of the Adriatic railway system in Italy. 2800 w. Elec Rev, Lond—Oct. 2, 1903. Serial. 1st part. No. 58282 A.

We supply copies of these articles. See page 479.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

NEWS SUPPLEMENT

The Engineering Magazine—December, 1903

Coming Society Meetings.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Sec.: Prof. L. O Howard, Cosmos Club, Washington, D. C. Annual meeting, Dec. 28-Jan. 2, at St. Louis.

AMERICAN ECONOMIC ASSOCIATION. Sec.: F. A. Fetter, Ithaca, N. Y. Annual meeting, Dec. 29 to Jan. 1, at New Orleans.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, December 18, at Carnegie Hall, 154 W. 57th St., New York.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York Next meeting, April 27, at New York.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, 1904, at Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August. Annual meeting, Jan. 20.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. Sec.: W. M. Mackay, 12 W. 31st St., New York. Annual meeting, Jan. 19 to 21, 1904, at New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 1-4, at New York.

ARCHITECTURAL LEAGUE OF AMERICA. Sec.: J. B. Nettleton. Next meeting, April or May, 1904, at Pittsburg.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursdays of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Meeting of General Section, Dec. 10. Electrical, Mechanical and Mining Sections meet on different Thursdays.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Josepn C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August, and September, at Pierce Hall, Copley Square.

NEW JERSEY SANITARY ASSOCIATION. Sec.: J. A. Exton, Arlington, N. J. Annual meeting, Dec. 4 and 5, at Lakewood.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July, and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., 1904, at Utica.

NORTHWESTERN ELECTRICAL ASSOCIATION. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Jan. 20, at Milwaukee.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Irving H. Reynolds is about to retire from the Allis-Chalmers Company, and the duties of chief engineer will be assumed by the engineers in charge of the various departments, these engineers availing themselves of the advice of Mr. Edwin Reynolds, consulting engineer of the company.

—Mr. George W. Colles, M. Am. Soc. M. E., has resigned his position as chief engineer of Marion & Marion, Montreal, and has opened an office as consulting mechanical and electrical engineer in Milwauke, Wis.

—Mr. J. M. Martin has resigned his position as district sales agent at the Philadelphia office of the Nernst Lamp Company, and Mr. A. E. Baker has been appointed as his successor.

—Mr. John Calder, who has been with the C. W. Hunt Company as its executive engineer, left on Saturday, November 14th, for Ilion, N. Y., where he will be connected with the management of the Remington Typewriter Company. Before leaving, he was treated to a pleasant surprise. A few

minutes before the noon hour, members and employees of the company gathered around his desk to participate in the presentation of a handsome silver loving cup suitably inscribed. Mr. George S. Humphrey presented the token to him, with a few appropriate remarks, expressing the esteem in which he was held both professionally and personally by the donors. Mr. Calder made a brief impromptu reply, expressing his thanks for the gift and his regret at severing the pleasant associations he had formed while in the employ of the C. W. Hunt Company. While this company loses an efficient officer, the Remington Typewriter Company is to be congratulated on the acquisition of a man of Mr. Calder's ability and standing.

—Mr. Robert O. Cumback, for several years with the C. R. R. of N. J., and now located at the Elizabethport shops on special work, has accepted the position of superintendent of the new plant of the Pedrick & Ayer Company, located at Plainfield, N. J.

—T. J. Heller, formerly New York agent for the Federal Manufacturing Co., for their steel ball department, has left that company and has taken the sales management of the ball business of the Standard Roller Bearing Co., who have recently purchased the ball business of the Grant Tool Co. Mr. Heller will make his headquarters with the Standard Roller Bearing Co., at 48th St. and Girard Ave., Philadelphia.

—Mr. F. B. Duncan has recently been appointed manager of the Akron Electrical Manufacturing Company. About two years ago, Mr. Duncan resigned his position of general superintendent, which he held for about five years, with the Northern Electrical Manufacturing Company, Madison, Wis., to accept a similar position in the Akron Company and his present promotion is an evidence of the latter company's appreciation of his services.

Industrial Notes.

—Red-clay roofing tiles have for centuries been used in England and on the continent of Europe, their durability and consequent cheapness earning for them unqualified endorsement from engineers there. Like recognition is sure to be won here from engineers who use them. In the entire catalogue of roofing material there is nothing to equal them in the essential qualities of a roof; they are fire-proof, lasting, cool and speedily laid. Their adoption would prove a lasting testimony to the foresight of an engineer designing warehouses, piers, sheds, stations, or any of the structures appertaining to railroad systems. To take the place of skylights, which are generally sources of constant repair and expense, and to provide light wherever desired in the roof, of any sized surface, Henry Maurer & Son, of New York, have introduced heavy tough glass tiles of the identical shape and size of the red-clay tiles, and consequently interchangeable; so that even after a roof is completed, and it should become necessary to provide further light through any part thereof, the red-clay tiles can be removed and the glass ones inserted in their place at the slight cost of the labor of taking out and replacing. Henry Maurer & Son are using these glass tiles in the different buildings of their plant and can fully confirm their adaptability to the purposes indicated, and in the roofs of the buildings of the Barber Asphalt Paving Co., shown elsewhere in this issue, several have been inserted and give great satisfaction. The design of both the red-clay and the glass tiles is so practical and simple that almost any one can erect them; they overlap and lock, their own weight holding them in position. Or, if further security is desired, the tiles are formed on the bottom to admit of their being fastened to the purlins of the roof with copper wire.

—The Willamette Iron & Steel Works, of Portland, Oregon, have recently taken contracts for two 2,000-horse-power electric lighting steam engines for the Portland General Electric Co., one complete fireboat, with a capacity of 6,000 gallons per minute, for the city of Portland, and the boilers and machinery for a large tugboat for the Gray's Harbor Tugboat Co. The Willamette Iron & Steel Works have also brought out lately a new type of logging engine for yarding logs, which has received a great deal of favorable comment and is a very satisfactory machine.

—The American Sewage Disposal Company, of Boston, has published an interesting pamphlet on "Sewer Building and Sewage Disposal by the American System."

by John N. McClintock, A.M., C.E., its president and general manager. This book gives a history of the discoveries and inventions of the late Amasa S. Glover, and describes and illustrates the application of his system of sewage disposal in various places. Sewage disposal in general is discussed, and there are accounts of a number of successful plants. Another pamphlet, by the same author, is issued by the American Water Purification Company, also of Boston, and is devoted to "Water and its Purification by the American System," which system it describes and illustrates.

—The steam power plant of the St. Louis Exposition, now being built by Messrs. Westinghouse, Church, Kerr & Co., will be fitted with two large central condensing units, each consisting of a 40-inch elevated condenser capable of handling 96,000 pounds of steam per hour. These condensers are being built by Henry R. Worthington, of New York City, who will supply centrifugal pumps for handling the circulating water. That company will also furnish the rotative dry vacuum pumps which will remove all air from the condenser system. The boiler-feed pumps of this immense power plant are likewise of Worthington make.

—The Under-Feed Stoker Co. of America, at Chicago, are publishing a monthly paper, called "The Publicity Magazine," which contains illustrations and descriptions of the Jones under-feed mechanical stokers, and of various plants where they are installed, interesting and entertaining items from various sources, and general news and information.

—Arthur Koppel, the manufacturer of narrow gauge railway materials, has issued an attractive booklet, containing a great variety of useful information in convenient form, calendars for 1904, 1905 and 1906, and blank pages for memoranda.

—President Duntley, of the Chicago Pneumatic Tool Company, in referring to the affairs of his company, says that it has paid promptly all its interest and sinking fund charges on its bonded indebtedness. It has declared its dividends out of actual earnings, after writing off all expenses, fixed charges, and allowing liberally for depreciation of plants, etc. It has paid its dividends out of its own moneys. It does not owe a dollar of borrowed money. It has no floating indebtedness, except current monthly bills for material and supplies, which do not exceed $48,000, and these it is ready to pay promptly when due. The company has over $1,000,000, in quick assets over and above all current liabilities, including current bills, accrued interest, dividends, etc. Its net earnings for the past nine months are $513,224. Its present business and the outlook for the future are satisfactory in every way. Its European business is growing faster in proportion than the local business. The company is now selling its tools and machines in every civilized country in the world, and is no longer dependent on the American trade for its business. These are facts, and the company's record shows the payment of every obligation, no borrowed money, no current indebtedness, except its monthly bills, and a large surplus in quick assets. The regular annual statements will be made and published at the end of the year.

—A freight station has been established at Ampere, N. J., by the Delaware, Lackawanna & Western Railroad Company. All goods for the Crocker-Wheeler Company, should be addressed therefore to Ampere, N. J., Per D. L. & W. R. R. A daily through car service has been established between Ampere and Pier 41, North River, New York, foot of Le Roy street. All goods for the Crocker-Wheeler Company from New York City and points east should, therefore, be delivered at the Lackawanna terminal, Pier 41, North River, New York. The receipt of freight closes at this point at 4:30 P. M., and the goods will arrive at Ampere the next morning. The receipt of freight at Ampere closes at 5 P. M., and the goods will arrive at Pier 41, North River, the next morning.

—The Lunkenheimer Company, of Cincinnati, the well-known manufacturers of superior brass and iron steam specialties and engineering appliances, have opened a branch office in Paris, at No. 24 Boulevard Voltaire, where they carry a complete stock of their goods.

—The success of the new medium-speed Corliss engine recently brought out by the Ball Engine Co., of Erie, Pa., has been so great that is was found necessary to greatly increase the capacity of this company's plant. Entirely new works were determined

upon and an ideal location was selected These works have been under construction during the past year, and the company has just moved into them. Although this was a large undertaking, it was accomplished without accident or any appreciable interruption of product. The new works are the most modern in the country, well lighted, and finely equipped, so giving the Ball Engine Co. unequalled facilities and a very large capacity.

—William W. Nugent & Co., of Chicago, the manufacturers of oiling and lubricating devices, receive many letters from their customers, of which the following, written by Mr. Thomas Baker, of Hilliards, O., is an example: "I write this to thank you for your valuable book on 'How to Oil an Engine,' which I received O. K. I can say that I am using in the plant where I am assistant engineer one of your patent, pendulum, dust-proof, crank-pin center oilers and it is the finest and best oiler that I have ever used. It is attached to a 500-horse-power Vilter-Corliss engine and it gives perfect satisfaction."

—Work is fast nearing completion upon the new power plant of the B. F. Sturtevant Co., at Hyde Park, Mass. This bids fair to be one of the most complete plants of its kind in the country, special care having been taken in connection with every detail to secure the highest efficiency and the most modern equipment. The plant will comprise four water-tube boilers, with stokers supplied by Sturtevant forced draft, an economizer with Sturtevant induced draft, and a complete outfit of Sturtevant generating sets, together with condenser, air compressor, etc. The Sturtevant exhaust head is used for separating the water and oil from the exhaust steam.

—The Stanley Electric Mfg. Co., of Pittsfield, Mass., have sold a 2,000-kilowatt revolving field generator to the Memphis Consolidated Gas & Electric Co., Memphis, Tenn.

—The steamship "Manchuria," of the Pacific Mail Steamship Company, was recently launched by the New York Shipbuilding Company, at Camden, N. J. The "Manchuria" has a length of 615 feet 8 inches, a breadth of 65 feet, and a depth of 51 feet, 3 inches. Its displacement is 26,514 tons, its gross tonnage, 13,500, and its indicated horse power, 12,000, and it will have a speed of 16 knots. Its passenger capacity will be 350 first cabin, 68 second cabin and 1,300 steerage.

—Wm. B. Scaife & Sons Company, of Pittsburg, manufacturers of the Scaife and We-Fu-Go systems for softening and purifying water, have appointed Mr. C. A Malau, of the City of Mexico, their sole representative in that republic for the sale of their various systems of water purification. The Scaife Company are now manufacturing every type of water purifying system, either intermittent or continuous and for treating the water either hot or cold. Their extensive experience in this line eminently fits them for carrying out any kind of water purification which they undertake. They are now softening and purifying 350,000,000 gallons of water daily for steam boilers and other industries where pure soft water is desirable, with their various systems. Mr Malau is especially well fitted to look after his clients in Mexico, as he is thoroughly acquainted with the engineering and industrial wants of that country, and has devoted considerable attention to the subject of water purification.

—Mr. F. Newton Heany has recently brought out a field book for engineers, which possesses some novel and convenient features. To facilitate field sketching, there has been placed on the right-hand pages, in addition to the usual ruling, a protractor, or circle, graduated to 5 degrees, and ruled in thin, red lines. There is also a vertical red line through the center of the circle and running the length of the page. The book is bound so as to open flat, and will be found a very handy one for field work. It is published by Wm. G. Johnston & Co., 396-398 Broadway, New York.

—The Westinghouse steam turbine is rapidly increasing its field of usefulness. The Eaton Cole & Burnham Company, of Bridgeport, Conn., are preparing plans for a turbine plant which will furnish power to their works. Large extensions to the present works are now under way and the entire plant will then be operated by polyphase motors from the new power station. A 400-kilowatt Westinghouse turbine unit will be immediately installed to provide additional power during the construction work. It will be temporarily installed in the pres-

ent power house and will operate under 200 pounds steam pressure and 28 inches vacuum, without superheat. The unit will furnish three-phase current at 440 volts. The installation is in charge of Mr. Geo. Hooper, engineer, of 11 Broadway, New York.

—The water supply of the City of Washington is shortly to be improved by the construction of a large filtration plant, work on which is now in progress under the supervision of Lieut. Col. A. M. Miller, Corps of Engineers, U. S. A., and Mr. Allen Hazen, consulting engineer. The contract for the centrifugal pumps and the engines has been awarded to the Worthington Company of New York, who will supply three 36-inch pumps of the triple-vane impeller type, each direct connected to a Harrisburg, four-valve, tandem-compound, condensing engine. Each unit will be capable of supplying 30,000 gallons of water per minute at a total head of 35 feet. The Government specifications require an exceptionally high efficiency in the pumping equipment and every part of the plant will represent the latest and best practice. The company supplying the centrifugal pumps will also furnish the wash-water pumps, which will be of the direct-acting, compound, condensing type.

—The West Side Young Mens' Christian Association, whose headquarters are at 318 West 57th St., New York, offers a number of courses of instruction in drawing, mathematics, languages, music and many other subjects, which are given in the evening, under the direction of highly competent teachers. Further information regarding these opportunities may be gained by sending a 2-cent stamp for the 64-page illustrated annual catalogue of the West Side Y. M. C. A., or by calling at the building and inspecting the plant.

—The Insurance Engineering Experiment Station, of which Edward Atkinson, of 31 Milk St., Boston, is director, and which is under the supervision of the Board of Directors of the Boston Manufacturers Mutual Fire Insurance Co., has issued a report by Prof. Charles L. Norton, who is in charge of the Experiment Station, on the "Fire and Heat Resistance of the American Luxfer Prism Company's Electro-Glazed Prism and Plate Glass." The report describes and illustrates the tests which were made in the kiln of the Experiment Station, and which gave results that are very favorable to the glass of the Luxfer Prism Company.

—The Crocker-Wheeler Company, of Ampere, N. J., has recently received a number of notable orders, and these, being fairly evenly distributed among its larger branch offices, indicate that the improving condition of business is not local to any one section. One order, from the Lorain Steel Company, Lorain, O., received through the Pittsburg office, called for 41 motors, ranging in size from 2½ to 360 H. P., and representing a total of 1,423 H. P. Another large order came from the New Jersey Zinc Company, of Hazard, Pa., through the New York office, for one 125- and two 600-K. W. generators, and 37 motors aggregating 401 H. P. The Philadelphia office placed an order from the Warren Foundry & Machine Company, of Phillipsburg, N. J., for one 200-K. W. generator, four 35-H. P. and two 60-H. P. motors, and, through the Chicago office, the G. H. Hammond Company ordered for its packing plant at the Union Stock yards in that city, one 50-, one 25- and two 20-H. P. motors, and an 800-K. W., 550-volt, size 896, engine-type generator. This last is a duplicate of one now building for the St. Louis Exposition, the entire intramural plant for which will be operated by generators supplied by the Crocker-Wheeler Company.

—The Thos. H. Dallett Co., of Philadelphia, report that the outlook for business has never been more encouraging than at the present time. They are receiving a larger number of inquiries than ever before, from all parts of the country and abroad, for their portable electric and rope-driven drills, pneumatic hammers, hand drills, stone-surfacing machines, carving tools, plug drills, etc., and they have booked many large orders from well-known firms here and in Europe, among whom are the U. S. Metal & Wrecking Co., New York; Milne & Chalmers, Quincy, Mass.; Manning, Maxwell & Moore, New York; Robert Wood, Philadelphia; Henry A. Hitner Sons, Philadelphia; Allentown Boiler Works, Allentown, Pa.; Sangamon Coal Co., Springfield, Ill.; Cutter, Wood & Stephens Co., Boston, Mass.; Schuchardt & Schütte, Berlin and Vienna; Niles-Bement-Pond Co., New York

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine When you write.

Air Compressors.

Catalogue No. 33 B, with descriptions and illustrations of straight-line, half-duplex, duplex and compound high-duty air compressors, driven by steam, electricity, Pelton and turbine water wheels, gas and oil engines, for all kinds of service. 9 by 6 in.; pp. 112. Ingersoll-Sergeant Drill Co., New York.

Automobiles.

Bulletin No. 10, illustrating and describing electric storage battery tractors, designed to meet the requirements for the haulage of material in and around large shops and plants, without tracks. 11½ by 8 in.; pp. 4. Also, Bulletin No. 11, devoted to electric storage battery trucks. Gibbs Engineering & Manufacturing Co., 555 East 116th St., New York.

Bending Machines.

Booklet, with illustrations, descriptions and prices of eye benders, angle benders and other hand bending tools, samples of the work which they perform, and list of users. 6½ by 3½ in.; pp. 14. Estep & Dolan, Sandwich, Ill.

Box-Car Loaders.

Catalogue, with full and detailed illustrations and descriptions of box-car loaders, operated by steam engine or electric motor, for loading any size of bituminous or anthracite coal, ore or other minerals into box or stock cars, and testimonials from users. 9 by 7 in.; pp. 57. Christy Box-Car Loader Co., Des Moines, Iowa.

Circuit Breakers.

Mailing card, devoted to I-T-E circuit breakers for affording automatic and instantaneous protection to electric motors and generators against excessive currents. 6 by 4 in. The Cutter Co., 19th and Hamilton Sts., Philadelphia.

Condensers.

Bulletin No. 1, with an illustrated description of the latest style of saturing-air surface condenser, constructed on the Pennell system of atmospheric condensation. 10 by 6 in.; pp. 4. Arthur Pennell, 300 Heist Building, Kansas City, Mo.

Cranes.

Pamphlet, with illustrated description of full-circle revolving locomotive cranes and derricks, built for any capacity and for standard, narrow and broad gauge. 5 by 8 in.; pp. 7. Frank B. Stratford, 95-97 Liberty St., New York.

Crushers.

Folder, with illustrations of Sturtevant steel roll jaw crushers for fine work, steel sectional crushers and other styles of roll jaw crushers. 9 by 6 in.; pp. 4. Sturtevant Mill Co., Boston.

Electric Lamps.

Catalogue No. 1, with a cover of unique design, and containing descriptions and half-tone illustrations of "Star" incandescent electric lamps in many standard and special styles, their manufacture and operation. 9 by 6 in.; pp. 43. Standard Electrical Manufacturing Co., Niles, Ohio.

Electric Machines.

Bulletin No. 146, with illustrated descriptions of several types of dynamos and electric motors, including compact generating sets, portable motors for testing purposes, motors with vertical shafts and other styles, and illustrations of their application to driving machinery and to other uses. Also, Bulletin No. 147, with list of some of the users and some of the principal installations of C & C generators and motors. 10 by 7½ in.; pp. 16. C & C Electric Company. 143 Liberty St., New York.

Graphite Lubricants.

Pamphlet with illustrated descriptions and price list of Dixon's graphite lubricants for automobile and cycle chains, piano actions, yacht bottoms and a great variety of other uses, graphite greases and compounds, and a list of Dixon's graphite productions. 7¾ by 5 in.; pp. 20. Joseph Dixon Crucible Co., Jersey City, N. J.

Heavy Machinery.

Booklet, with announcement of facilities for the building of heavy machinery of all kinds, including machinery for sugar works, cement plants, rolling mills, mines, smelters, etc. 6¼ by 3½ in.; pp. 3. Quincy Engine Works, Quincy, Ill.

Hydraulic Mining.

Catalogue No. 5, fourth edition, with illustrations and descriptions of the Evans hydraulic gravel elevators, riffles, gold-saving tables, undercurrents, hydraulic giants for directing a stream of water, water lifts, pipe connections and other kinds of hydraulic mining machinery, together with useful tables and data. 10 by 7 in.; pp. 48. Risdon Iron Works, San Francisco.

Logging Engine.

Circular, with illustrated description of the "Willamette Crackajack," a big drum engine for yarding logs. 8½ by 5½ in. Willamette Iron & Steel Works, Portland, Oregon.

Machine Tools.

Booklet, with illustrations and descriptions of modern high standard lathes, planes, shapers, upright drills, radial drills and boring mills for rapid work production. 3½ by 6 in.; pp. 16. American Tool Works Co., Cincinnati.

Mechanical Draft.

Sectional catalogue No. 118, second edition, devoted to the "A B C" system of mechanical draft, forced and induced by blowers and exhaust fans, with descriptions and illustrations of the various kinds of apparatus employed, and useful tables and data. 8¾ by 7¼ in.; pp. 60. Also, catalogue No. 145, devoted to the heating and ventilation of manufacturing establishments. 9 by 7 in.; pp. 32. And catalogue No. 155, with illustrations and descriptions of steel-plate fans. 8¾ by 7¼ in.; pp. 74. American Blower Co., Detroit.

Cloth-bound catalogue of Buffalo mechanical-draft apparatus, showing applications of induced and forced mechanical draft in street railway and electric light central stations, steamship plants and industrial works, with illustrations and descriptions of suitable fan types. 7½ by 9 in.; pp. 123. Buffalo Forge Co., Buffalo.

Paint.

Index catalogue and price list, with descriptions of Mogul preservative paints, compounds and varnishes, a long list of the ways in which they can be profitably employed, and illustrations of some of the uses to which they have been put. 5½ by 4½ in.; pp. 64. A. Grothwell, 26 Montgomery St., San Francisco.

Pneumatic Tools.

Circular No. 10, with illustrations and descriptions of piston air drills, air motor hoists, pneumatic wood-boring machine, chipping and riveting air hammers, air hose, air compressors, and other pneumatic tools and appliances. 12 by 9 in.; pp. 12. Rand Drill Co., 128 Broadway, New York.

Presses.

Bulletin No. 1, with detailed descriptions and illustrations of the inclinable, open-back power presses for general manufacturing purposes, and of pendulum foot presses. 9 by 6 in.; pp. 12. Consolidated Press and Tool Co., Chicago.

Pumps.

Catalogue No. 31, with descriptions and half-tone illustrations of feed pumps, fuel-oil pumps, fire pumps, oil-line pumps, air pumps and condensers, mining pumps, sinking pumps, hydraulic pumps, and other kinds of standard and special steam pumps. 9 by 6 in.; pp. 144. A. S. Cameron Steam Pump Works, New York.

Railway Signals.

Catalogue and price list, No. 5, with illustrated descriptions of highway crossing signals of various types, and all their parts and accessories; electric block signals, both semaphore and disc; highway crossing gates; and other kinds of railway signal apparatus and supplies. 9 by 6 in.; pp. 40. The Railroad Supply Co., Chicago and New York.

Steam Goods.

Cloth-bound pocket catalogue, with illustrations, descriptions and prices of standard pressure valves and cocks, in brass and iron, fittings for steam, gas and water, extreme high pressure and hydraulic pressure valves and fittings, drainage fittings, steam and gas fitters' tools, engineers' and engine builders' supplies, hose goods, wrought pipe, and other kinds of steam, water and gas specialties. 7 by 4¼ in.; pp. 464. Crane Co., Chicago.

Steam Specialties.

Catalogue No. 9, with clear illustrations and detailed descriptions of "Emergency" steam traps, "Victor" low-pressure steam traps, improved safety water columns with automatic alarm, "Cyclone" exhaust heads, and other up-to-date steam specialties. 9 by 6 in.; pp. 32. Wright Manufacturing Co., Detroit.

Storage Batteries.

The "Exide Battery" Instruction Book, containing comprehensive directions for the operation and care of this storage battery in electric vehicles, with descriptions and illustrations of the battery and its parts. 8½ by 5 in.; pp. 31. The Electric Storage Battery Co., Philadelphia.

Track.

Large, cloth-bound catalogue No. 10, with descriptions, half-tone illustrations and line cuts of frogs, switches, crossings, derailing switches and a great variety of other kinds of rail and special track work for street railways and steam railroads. 8¾ by 11 in.; pp. 180. Wm. Wharton, Jr., & Co., Incorporated, Philadelphia.

Unloader.

Catalogue, with description of the Rapid Unloader for discharging dirt, ballast, ore, etc., from flat cars and throwing track in railroad work, and of the Leveler for handling earth in railroad construction, together with many half-tone illustrations of these machines in operation. 6 by 9 in.; pp. 48. The Lidgerwood Mfg. Co., New York.

Valves.

Catalogue and price list, with illustrated descriptions of iron and bronze gate valves, special hose valves and Siamese connections, gate valves and indicator devices for automatic sprinkler systems, globe, angle, radiator and corner valves, hydrants, extension valve boxes and floor stands, and other types of valves and their details. 5 by 9 in.; pp. 128. The Kennedy Valve Manufacturing Co., 57 Beekman St., New York.

Well Machinery.

Circular, form 88, containing sample pages from a larger catalogue, with illustrations and descriptions of Chapman's air-lift pumping system, air compressors, steam and gasoline pumping engines, working barrels for wells, artesian well screens, vertical centrifugal pumps, drilling tools, and other deep-well pumping appliances. 9 by 6 in.; pp. 32. American Well Works, Aurora, Ill.

Wood-Working Machinery.

Catalogue pages, with illustrations and description of a fast-feed flooring machine, with improved belt-feed, made in three sizes, to plane 10, 12 and 15 inches wide by 6 inches thick. 10½ by 7½ in.; pp. 4. H. B. Smith Machine Co., Smithville, N. J.

IMPROVED MACHINERY

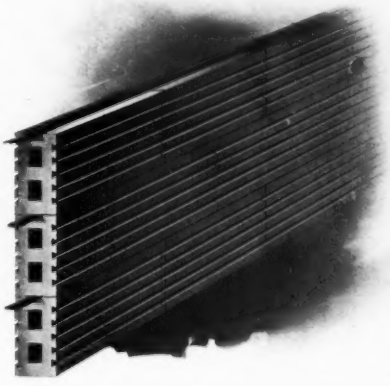
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A New Form of Wall Construction Especially Adapted to Factories, Shops and Piers.

THE serious labor troubles in the building trades in New York City have developed a situation which is full of instruction for engineers and architects everywhere who may have occasion to deal with similar conditions.

The structural iron workers, for example, have tied up most of the great sky-scraper buildings in course of erection; and supplementing this difficulty, labor strikes in the Haverstraw region have already resulted in reducing the annual output of red brick no less than 600,000,000 —in other words, more than one-half the total annual supply. Added to this are the late floods, which promise to further reduce the output some 500,000,000 more, or practically a full year's output. The result is that New York City has ahead of it at least a full year of great scarcity in the supply of red brick.



"PHOENIX" WALL CONSTRUCTION.

Naturally enough, the price of red brick has already advanced from $7.25 per thousand, a high price, to no less than $9.50 per thousand; and it is very difficult to get them at the latter price. But "necessity is the mother of invention," and by reason of this oft-demonstrated fact, it is well worthy of the attention of engineers, architects and inventors generally, that we now bring to special notice a substitute for red brick outer-wall construction, which is not only novel, new, and cheap, in comparison with the ordinary brick wall, but which the manufacturers represent to be actually better —as well as immediately available—for those who have need to substitute it for what has heretofore been used.

The American Smelting & Refining Company, about a year ago, contracted with Messrs. Henry Maurer & Son, patentees and manufacturers, for a tank house 350 feet long by 250 feet wide and 24 feet, 6 inches high, at their works in Perth Amboy.

The construction consists of hard-burned terra-cotta hollow blocks 4 by 8 by 12 inches, forming walls of either 4 or 8 inches thickness; or blocks to suit any thickness of wall desired; "I" beams, 6, 7 or 8 inches deep and band-iron No. 18, 1/16 inch by 1 inch wide; the method as follows:—the "I" beams, of lengths corresponding to height of wall, are placed upright and spaced about 15 feet apart; between the spaces a course of the hollow blocks is laid; on top of every second course a continuous strip of band-iron, fitting in the grooves of the blocks, is laid in Portland cement; the ends of the band-iron riveted to the upright "I" beams.

The construction is known as the "Phœnix" and is covered by Letters-Patent.

It is conceded by engineers who have

WORKS OF THE BARBER ASPHALT PAVING CO. AT MAURER, N. J.

used this method, that a "Phœnix" wall 4 inches thick, with light steel work, is equal in rigidity and strength to one of common brick 12 inches thick; and the weight per square yard of wall of the former being but as 216 pounds to 760 pounds for the latter, one great advantage is at once apparent; hence also it is only essential that the foundations of the "Phœnix" method be solid under the "I" beams; a light one serving for the support of the wall spaces between the upright beams.

The factor of safety is ample; architects allow from 5 to 10 tons per square foot for pressure on masonry, and the "Phœnix" blocks, 4 by 8 by 12 inches, placed edgewise and tested by a 100,000-pound "Riehle" testing machine, showed 59.6 tons to the square foot crushing weight; this factor being further increased by the fact that a square yard of the 4-inch "Phœnix" wall weighs but 216 pounds as against 760 pounds of the common brick one, a difference of considerable weight where the items of freight and cartage enter into computation.

The building cost, per square yard of the two walls, based on current prices for labor and material in New York City, taking, however, $7.25 per thousand for common brick (a very conservative estimate), we find the common brick wall to cost $3.55 per square yard and the Phœnix" $2.05.

The estimated saving of weight of the tank-house at the American Smelting & Refining Works was 1,700,000 pounds.

After an inspection of that work and several other buildings at Maurer, N. J., the engineers of the Barber Asphalt Paving Co. contracted with the manufacturers, Henry Maurer & Son, for the erection of the buildings at their new plant; several of these being completed, we show cuts thereof, which explain themselves. Further information may be obtained from Messrs. Henry Maurer & Son, New York City.

WORKS OF THE BARBER ASPHALT PAVING CO., AT MAURER, N. J.

Electric Motor Starter Panel.

THE advantages of a complete motor starter panel for use with variable speed motors are apparent to all who have had practical experience with the latter. The method employed for regulating the speed of a variable speed motor is to vary the amperes flowing in the field circuit by using a rheostat in series with the field.

The oldest practice was to have the field rheostat a part of the box used for starting the motor, but this practice has been stopped owing to the fact that a box with automatic features did not allow a sufficient number of field points of control and the motor therefore jumped between steps. It is not practicable to use a separate field rheostat in order to get a large number of steps for field control without taking precautionary steps against the danger of overloading the armature if the motor is started under conditions of weakened field.

MOTOR STARTER PANEL.

The cut on this page shows a panel consisting of a starter so interlocked with a field rheostat that the motor cannot be started under conditions of weak field. A starter which has the no-voltage release magnet connected in series with the field is objectionable for the reason that when the field is weakened in order to alter the speed, the magnet is weakened and the arm flies back, stopping the motor. The panel shown here has the following advantages over any type of panel now before the public:

(1) It is self-contained and complete. (2) The no-voltage magnet is connected across the armature terminals and is independent of the amperes in the field. (3) The device is a positive protection against overload at all times and consists of an independent interlocking overload circuit breaker. (4) The field rheostat has any number of steps desired, from 30 to 150, or more, giving perfect, even regulation. (5) The field rheostat and starter are so interlocked that the motor cannot be started under conditions of weak field. (6) The whole panel is waterproof, rustproof and proof against short circuits usually met with in an open box, owing to the filling up by chips, etc. (7) This panel fulfills the United States Government specifications, the most accurate and strict of those covering motor starters.

This panel is manufactured by the Ward Leonard Electric Co., of Bronxville, N. Y., who will be glad to furnish any further information that may be desired.

Hot Water Meters for Boiler Tests.

EVERY engineer who has control of a boiler plant must feel the necessity of having some simple device by which the amount of water fed to the boiler can be accurately measured. With such an appliance at hand, it becomes an easy matter to test the evaporative values of various coals with a view to determining which of the several is the most economical in developing power.

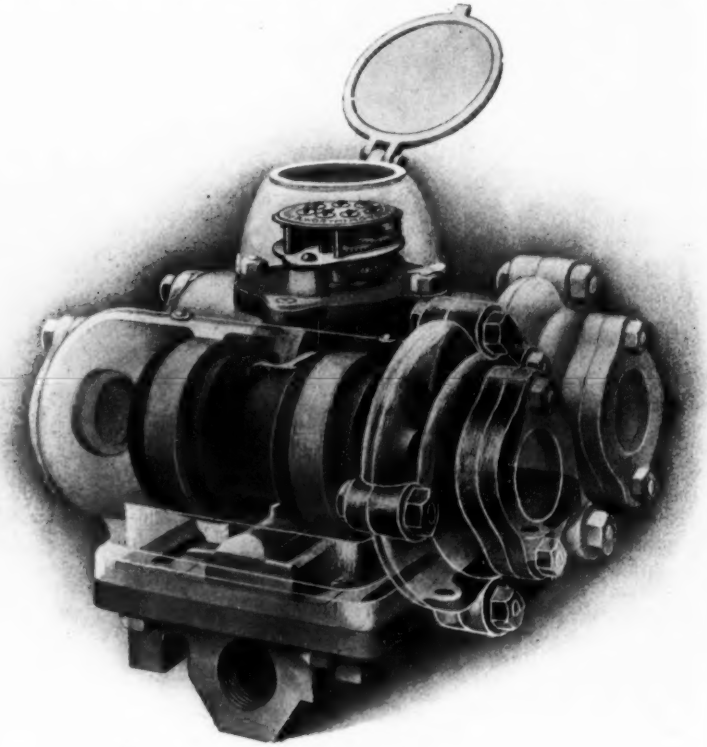
There was a time when it was not necessary to keep a close record of the cost of operation of large power plants, but now the ever increasing competition and the necessity of lowering the cost of production demand the very closest scrutiny into every possible source of economy. In central electric power stations, and in large manufacturing establishments, where the cost of power is an important item in the cost of the product, a very careful record should be kept of the performance of the boiler plant, and there are but few, if any, plants to-day that do not keep a close record of the coal consumption. But while this is valuable information in itself, it is only part of the data that should be obtained. If the amount of water evaporated is not known, there is no way of separating the performance of the boiler itself from the balance of the plant.

This separation is important, indicating, as it does, the efficiency of the boilers. It

shows when the boiler is affected by scale or soot, and determines the most economical fuel, as well as indicates the best method of firing, either by hand or by mechanical stokers.

In the past, the customary method of determining the amount of boiler feed water has been by weighing or measuring it. This is very laborious, even for short tests, and is utterly impracticable for daily work. The use of the feed-water meter, on account of its simplicity, accuracy and reliability in evaporative tests, is now almost universally adopted by engineers for daily work, as well as for trial tests.

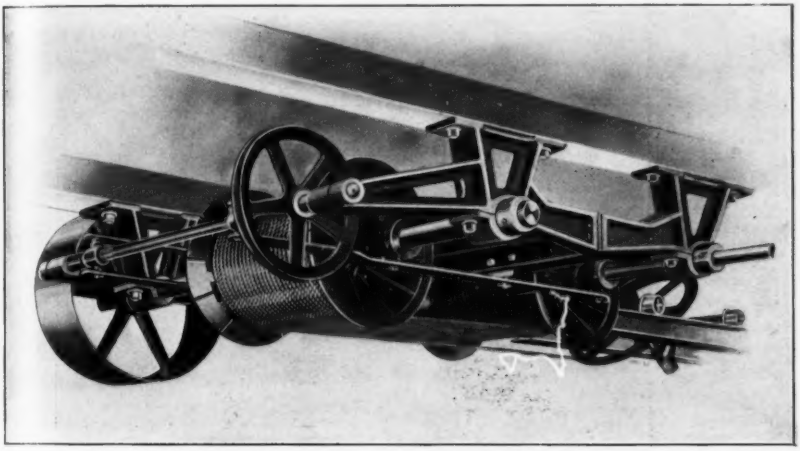
The most reliable test meters are of the positive displacement type, the best known of which is the duplex pattern, measuring water by the means of two chambers alternately filled and emptied by the motion of their pistons. These meters are so constructed that it is impossible to pass water without a corresponding registration, for in order to pass through the meter the water must be displaced by the motion of the pistons, and therefore recorded by the counter attachment. The pistons are closely fitted and move in parallel lines. The design, arrangement and construction of valves and parts is such that the strokes of the two pistons alternate, the valves actuated by one admitting pressure to the other. At the end of each motion, the pistons are brought to rest by adjustable buffers which determine the length of the stroke. One of the pistons is constantly in motion, giving uniform flow of water, free from pulsation or shock. The meters



WORTHINGTON HOT-WATER METER.

are perfectly noiseless in their performance. These test meters are designed and constructed of materials uniformly affected by expansion and contraction in passing water of varied degrees of temperature, thus further assuring their accuracy as measuring devices.

For an ordinary test, one of these meters was calibrated, the figures showing the meter to be correct to within one-fifth of one per cent. This is considered very satisfactory for ordinary every-day work. To obtain correct results, these test meters should be properly applied for operation, the size selected should be ample for the service, thus insuring slow piston speed, and pipe connections should be made so that at any time the meter can be cut out for examination or repairs without shutting down the boilers. The accompanying illustration shows one of these meters as manufactured by Henry R. Worthington, of 118 Liberty St., New York, who will be pleased to furnish any further information which may be desired.



STURGESS VARIABLE-SPEED ROPE TRANSMISSION.

Sturgess System of Variable-Speed Rope Transmission.

THE use of rope for transmission purposes has of late years assumed a position of considerable importance. One of its chief advantages is that the relation between the two shafts, between which power is transmitted, is not fixed within such comparatively narrow limits as is the case with belt drives.

This feature of rope transmission has been taken advantage of in the Sturgess variable-speed rope transmission, which is illustrated herewith, and which is used for driving paper and textile machinery, or for any other purpose where a speed-changing device is required.

In nearly all other forms of speed-changing devices short belts are used, which are undesirable on several accounts. It has been a difficult matter to properly compensate for the variations in length of such belts, owing to the fact that the length of a belt when passed around two expansible pulleys, the sum of whose diameters is constant, is not uniform unless the shafts are a great distance apart. Moreover, it is hard to make a pulley which will expand or contract and give a positive driving diameter.

The Sturgess rope transmission has two shafts, each carrying a pair of cones, the hubs of which are embraced by collars attached to a pair of controlling levers, which are pivoted at a point midway between the two shafts. These levers are operated by a right-and-left-hand screw, which may be rotated by a hand wheel, chain or rope wheel, or any other convenient connection.

In the face of the cones are milled a

number of dove-tailed slots which receive the dove-tailed ends of a number of segments, forming the periphery of the pulley. In these segments grooves are turned of proper shape to receive the rope. The milling of the slots is an operation requiring great exactness and care, for which special machinery has been constructed. All the corners and edges where the ropes enter and leave the segments are well rounded off and smoothed. The thrust from the cones is received on large ball bearings. The bearings being of the ring-oiling type the power absorbed by the transmission is small and its efficiency consequently high.

The speed variation obtainable is 5 to 1. As the pulleys are capable of high rotative speed, considerable amounts of power can be transmitted with apparatus occupying comparatively small space. The transmission is made in hanger, standard or wall-bracket forms, in sizes from 1 horse power to 150 horse power.

The tension carriage is constructed according to regular practice but may be arranged in a variety of ways to suit local circumstances. In the smaller sizes this is incorporated in the design of the counter-shaft, and in the larger sizes it is made separate.

This transmission is manufactured by the Sturgess Governor Engineering Company, of West Troy, N. Y., builders of the well known Sturgess water-wheel governors, who will gladly furnish any more information which may be desired.

The Triplex Block.

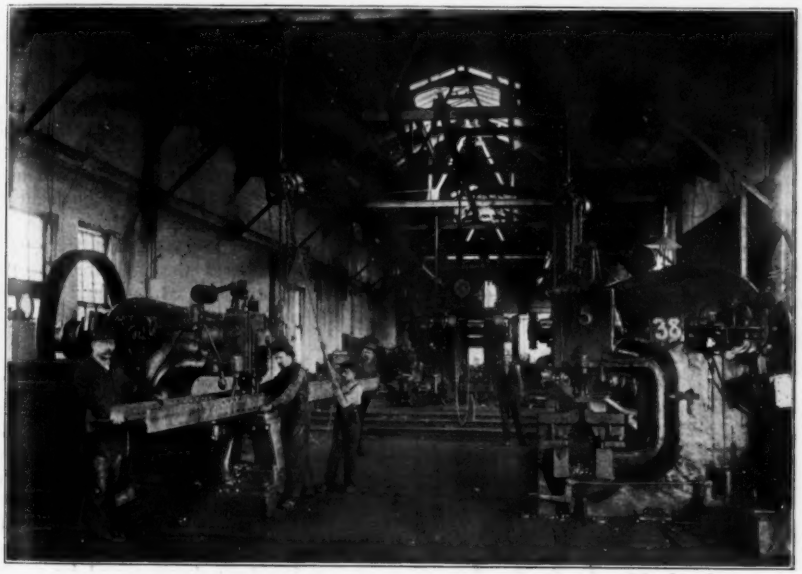
TWO types of machines are employed in the handling of heavy material, viz.: 1. A hoist, for vertical movement. 2. A crane or trolley, for horizontal movement.

TRIPLEX BLOCK AT A BRIDGE WORKS.

Where the load exceeds the lifting capacity of one or two men, the hoist is the absolutely essential factor, while the crane or trolley may or may not be necessary. In other words, in every machine of this class the hoist is the vital part.

In considering apparatus for transferring material, this fact is sometimes overlooked, and chief attention given to the mechanism for horizontal motion. While this is important, the mechanism for vertical motion, that is, the hoist, is still more important.

The simplest, most compact and most mechanical form of hoist is the triplex block, which has the further important advantage of possessing a higher mechanical efficiency than any other available machine. In its standard form, it is a portable machine, intended to be hung by its hook to some overhead support, either fixed or movable, but it is also arranged to be built into a trolley intended to travel either on a crane or on an overhead tramway. It is thus available as the hoisting device in almost every type of machine for the handling of material.



TRIPLEX BLOCK IN A SHOP.

Twenty tons may be lifted with it five feet in ten minutes, and three hundred pounds or less, thirty feet a minute. Where the load is less than a hundred pounds a quick-speed block often saves a great deal of unnecessary strain in reaching the required position.

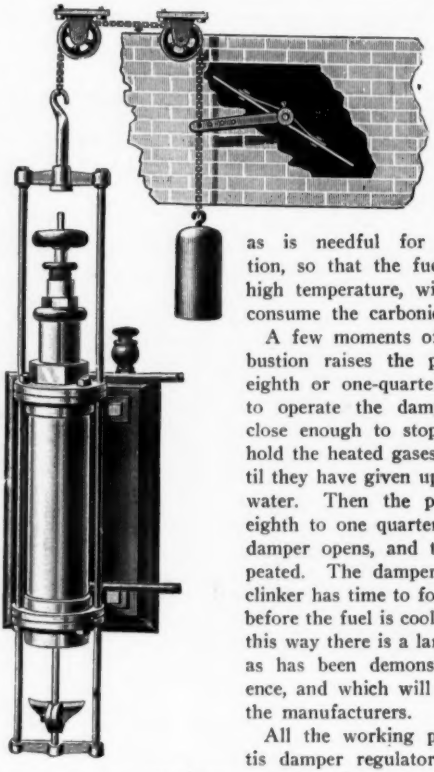
The accompanying illustrations show a few of the many possibilities offered by the triplex block as a hoisting device in apparatus designed for the transfer of material, and any further information desired will be gladly given by the Yale & Towne Mfg. Co., 9, 11, 13 Murray St., New York.

The Curtis Damper Regulator.

IT was formerly thought that a plunger damper regulator for boiler plants was far inferior to the diaphragm style, but within recent years a new regulator of the plunger type, manufactured under the Curtis patent, has been brought out and gives results which are superior to any hitherto attained.

Almost any form of regulator will do fairly well at times in a large plant, where the average amount of steam used varies but little, and in such cases the Curtis regulator will not allow a variation exceeding one quarter of a pound for the daily run, except when the boiler is being fired. But with water-tube and quick-steaming boilers where it is needful to close the damper promptly to prevent over-pressure, and to open it quickly when a sudden demand for steam is made, as in electric power and elevator plants, the Curtis damper regulators stand pre-eminent, and if they do not keep the boiler pressure well within an extreme variation of one pound, they are considered out of order, although many engineers would be satisfied with a much wider variation.

The Curtis regulator consists of a composition cylinder, accurately bored and reamed, within which is a long, loose-fitting plunger, fitted with water grooves, thus being both tight and frictionless. As the pressure is always one way, the plunger merely rests on the collar of the rod, and there can be no cramping even if the rod should be out of line with the bore of the regulator. The motion of the plunger is communicated by a yoke and chain to the lever of the damper, on which is hung sufficient weight to open the damper and overhaul the plunger. The plunger is operated by steam direct from the boiler, and the whole pressure in the boiler is therefore available to operate the damper if needful. As a matter of fact, only so much pressure is used as is required to lift the weight, usually not more than 10 pounds to the inch on the plunger. The admission of steam is controlled by a sensitive, metallic diaphragm, which operates the valve on a motion of a two hundredth of an inch, or one eighth of a pound pressure. To operate it, a given load—say 60 or 100 pounds to the inch—is produced on the regular diaphragm, by screwing the handle in. When the pressure in the boiler reaches the limit, it lifts this load, and permits steam to enter the space over the plunger, slowly pushing it down and closing the damper. When the boiler pressure falls below the limit, the valve closes, and the pressure, passing from the bottom to the top of the piston, puts the piston in equilibrium, and allows the weight, slowly settling down, to open the damper, thus controlling the pressure at the desired limit.



CURTIS DAMPER REGULATOR.

The hook in the top of the yoke is a turn-buckle, by means of which the chain can be lengthened or shortened at will, so that the damper can be shut so close as to prevent combustion and at the same time not throw out gas. By means of the clamp on the plunger rod at the bottom, the amount of opening of the damper can be changed at different seasons or with different kinds of coal.

The Curtis damper can be opened as wide as is needful for perfect combustion, so that the fuel is burned at a high temperature, with enough air to consume the carbonic oxide.

A few moments of this sharp combustion raises the pressure the one-eighth or one-quarter pound requisite to operate the damper, which shuts close enough to stop combustion and hold the heated gases in the boiler until they have given up their heat to the water. Then the pressure falls one eighth to one quarter of a pound, the damper opens, and the process is repeated. The damper is closed before clinker has time to form, and is opened before the fuel is cooled injuriously. In this way there is a large saving of fuel, as has been demonstrated by experience, and which will be guaranteed by the manufacturers.

All the working parts of the Curtis damper regulator are of the best material. They have been tested by years of service and have been found to be practically indestructible. Any further information concerning this regulator and the other Curtis engineering specialties, such as the improved pressure regulator, the improved pump regulator, the water-pressure regulator, the expansion, the return steam and the balanced steam traps, and the temperature regulator, will be gladly furnished by the manufacturers, the Julian D'Este Company, of Boston.